

**A CRITICAL EVALUATION OF CANCER CARE IN  
NIGERIA, COMPARATIVE ANALYSIS TO OTHER  
COUNTRIES, AND CUSTOMIZATION OF  
STANDARD CANCER CARE SYSTEM FOR  
NIGERIA**

**A THESIS SUBMITTED TO THE GRADUATE  
SCHOOL OF APPLIED SCIENCES  
OF  
NEAR EAST UNIVERSITY**

**By  
NUHU ABDULHAQQ ISA**

**In Partial Fulfillment of the Requirements for  
the Degree of Master of Science  
in  
Biomedical Engineering**

**NICOSIA, 2019**

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name:

Signature:

Date

**To all Victims of Cancer in Nigeria and the World**

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## ABSTRACT

Several countries and organizations are in the fight against cancer by creating awareness, developing new diagnostic, and therapeutic methods and providing financial support for patients and research. Development of a comprehensive cancer care system is key step for any nation to lower cancer incidence, mortality, and increase survival rate through extensive evidence-based research for prevention, early diagnosis, and treatment. A country's quality of cancer care is based on number of specialized physicians, cancer centers, cost, palliative care, survival rate, clinical services, national cancer control program etc.

Data provided by Globacom in 2012 shows that cancer rate in Nigeria has already reached pandemic level with an estimated 102,000 new cases yearly. More than 71,000 cancer death were recorded in Nigeria. Some of the critical factors challenging the status of cancer care include poor government funding, data, health system, inadequate cancer centers, available drugs, awareness, poverty, lack of oncologists, clinical engineers, other medical specialist, and lack of management/accountability at all levels. Hence, Nigeria is not effectively preparing to tackle the cancer catastrophe.

The study critically reviews the quality of cancer care in Nigeria and a comparative analysis with cancer care in other countries by fuzzy promethee. A customized cancer care system is proposed for Nigeria. Both qualitative and quantitative methods were used.

**Keywords:** Cancer care; Challenges of cancer care; Standard cancer care; Fuzzy promethee; Nigeria; Affordability of cancer care; Comprehensive cancer center.

## ÖZET

Birçok ülke ve kuruluş farkındalık yaratarak, yeni tanı ve tedavi yöntemleri geliştirerek ve hastalar ve araştırmalar için finansal destek sağlayarak kansere karşı mücadele etmektedir. Kapsamlı bir kanser bakım sisteminin geliştirilmesi, herhangi bir ülkenin önleme, erken tanı ve tedavi için kapsamlı kanıta dayalı araştırmalarla kanser insidansını, mortaliteyi düşürmesi ve sağkalım oranını arttırması için kilit bir adımdır. Bir ülkenin kanser bakım kalitesi, uzman hekim sayısına, kanser merkezlerine, maliyete, palyatif bakıma, hayatta kalma oranına, klinik hizmetlere, ulusal kanser kontrol programına vs.

2012 yılında Globacom tarafından sağlanan veriler Nijerya'daki kanser oranının yıllık 102.000 yeni vaka ile pandemik seviyeye ulaştığını göstermektedir. Nijerya'da 71.000'den fazla kanser ölümü kaydedildi. Kanser bakımının durumuna meydan okuyan kritik faktörlerden bazıları arasında zayıf devlet finansmanı, veri, sağlık sistemi, yetersiz kanser merkezleri, mevcut ilaçlar, farkındalık, yoksulluk, onkolog eksikliği, klinik mühendisleri, diğer tıp uzmanları ve tüm seviyeler. Dolayısıyla, Nijerya, kanser felaketiyle mücadelede etkili bir şekilde hazırlık yapmıyor.

Çalışma, Nijerya'daki kanser bakım kalitesini ve bulanık prometee ile diğer ülkelerdeki kanser bakımı ile karşılaştırmalı bir analizi eleştirel olarak gözden geçiriyor. Nijerya için özelleştirilmiş bir kanser bakım sistemi önerildi. Hem nitel hem de nicel yöntemler kullanılmıştır.

**Anahtar Kelimeler:** Kanser bakımı; Kanser bakımının zorlukları; Standart kanser bakımı; Bulanık prometee; Nijerya; Kanser bakımının satın alınabilirliği; Kapsamlı kanser merkezi

## TABLE OF CONTENTS

<b>ACKNOWLEDGEMENT</b> .....	ii
<b>ABSTRACT</b> .....	iii
<b>ÖZET</b> .....	iv
<b>LIST OF FIGURES</b> .....	vii
<b>LIST OF TABLES</b> .....	viii
<b>ABBREVIATIONS</b> .....	ix

### CHAPTER 1 : INTRODUCTION

1.1. Background of Study .....	1
1.2. Standard Cancer Care System.....	2
1.3. Fuzzy PROMETHEE.....	4
1.4. Statement of Problem.....	6
1.5. Aims and Objectives .....	7
1.6. Research Question .....	7
1.7. Methodology .....	8
1.8. Significance of the Study.....	9
1.9. Limitations of the Study .....	9
1.10. Organization of the study .....	9

### CHAPTER 2: LITERATURE REVIEW

2.1. Cancer in the World.....	11
2.2. Cancer in Developing Countries.....	14
2.3. Cancer in Nigeria.....	15
2.3.1. Trend in Cancer Incidence in Nigeria .....	15
2.3.2. Cancer mortality and Survivorship in Nigeria.....	17
2.3.3. Trending Cancer by Type in Nigeria.....	18
2.3.4. How Nigeria Is Handling Cancer Cases .....	22
2.3.5. Challenges of Cancer Care in Nigeria .....	24
2.4. Fuzzy Promethee.....	25
2.5. Summary .....	26



**CHAPTER 3: THE STANDARD CANCER CARE**

3.1. Introduction..... 28

3.2. A Comprehensive and Standard Cancer Care System..... 28

    3.2.1. Clinical Management..... 29

    3.2.2. Clinical Services ..... 31

    3.2.3. Core Services ..... 39

**CHAPTER 4: METHODOLOGY**

4.1. Introduction..... 45

4.2. Research Strategy ..... 45

4.3. Data Collection ..... 46

4.4. Selected Cancer Care Parameters ..... 49

4.5. Promethee Application for Comparing Cancer in Selected Countries ..... 55

**CHAPTER 5: FINDINGS AND DISCUSSION**

5.1. Promethee Result ..... 57

5.2. Customized Cancer Care System for Nigeria..... 59

**CHAPTER 6: CONCLUSION AND RECOMMENDATION ..... 68**

**REFERENCE ..... 70**

## LIST OF FIGURES

<b>Figure 1.1:</b> Parameters of cancer care in sequential order.....	4
<b>Figure 2.1:</b> Global trending new cases of cancer 2018 in millions (WHO, 2018) .....	12
<b>Figure 2. 2:</b> Leading causes of cancer deaths 2018 in millions (WHO, 2018).....	13
<b>Figure 2.3:</b> Estimated number of new cancer cases in Nigeria 2018 (Globocan, 2018)...	16
<b>Figure 2.4:</b> Estimated number of total cancer deaths in Nigeria 2018 (Globocan, 2018)..	18
<b>Figure 3.1:</b> Parameters for a comprehensive clinical service for cancer patients .....	33
<b>Figure 5.1:</b> Ranking showing the parameters for each alternative treatment destination in their positive and negative outranking flow .....	58
<b>Figure 5.2:</b> Parameters for customized cancer care in Nigeria.....	59

## LIST OF TABLES

<b>Table 2.1:</b> Ranking of cancers in Nigeria in terms of the rate of incidence and mortality for the year 2018. ....	19
<b>Table 2.2:</b> Trending cancer types in Nigerian men and women .....	21
<b>Table 4.1:</b> Linguistic scale of importance .....	47
<b>Table 4.2:</b> Selected cancer parameters.....	54
<b>Table 4.3:</b> Visual PROMETHEE Application.....	56

## **ABBREVIATIONS**

<b>AIDS:</b>	Acquired Immune Deficiency Syndrome
<b>BC:</b>	Before Christ
<b>CAD:</b>	Computer Aided Diagnosis
<b>CECP:</b>	Committee Encouraging Corporate Philanthropy
<b>CT:</b>	Computed Tomography
<b>eTA:</b>	Electronic Travel Authorization
<b>DPR:</b>	Doctors to Patient Ratio
<b>GDP:</b>	Gross Domestic Product
<b>HHS:</b>	United States Department of Health & Human Services
<b>HIV:</b>	Human Immunodeficiency
<b>IAEC:</b>	International Atomic Energy Agency
<b>IARC:</b>	International Agency for Research on Cancer
<b>ICIR:</b>	International Centre for Investigative Reporting
<b>ICT:</b>	Information Computer Technology
<b>IOM:</b>	Institute of Internal Medicine
<b>LINAC:</b>	Linear Accelerators
<b>LUTH:</b>	Lagos state university teaching hospital
<b>MCDM:</b>	Multi Criteria Decision Making Theory
<b>MRI:</b>	Magnetic Resonance Imaging
<b>NGO:</b>	Non-Governmental Organization
<b>NHIS:</b>	National Health Insurance Scheme
<b>NPC:</b>	National Population Commission of Nigeria
<b>NSIA:</b>	Nigeria Sovereign Investment Authority

<b>NYC:</b>	New York City
<b>OECD:</b>	Organization for Economic Co-operation and Development
<b>PACS:</b>	Picture Archiving and Communication Systems
<b>PET:</b>	Positron Emission Tomography
<b>PSA:</b>	Prostate Specific Antigens
<b>PROMETHEE:</b>	Preference Ranking Organization Method for Enrichment Evaluations
<b>SPECT:</b>	Single Photon Computed Tomography
<b>UK:</b>	United Kingdom
<b>USA:</b>	United States of America
<b>WHO:</b>	World Health Organization
<b>WSC:</b>	Welcoming Country Score

# CHAPTER 1

## INTRODUCTION

### 1.1. Background of Study

The occurrence of cancer in the world dates back to ancient Egypt in 3000 BC (American Cancer Society, 2018). According to an article by Fayed (2019), the first and oldest documentation of the disease was in the year 1500 BC in ancient Egypt. Since then, the world has witnessed the growth of cancer in to a global health catastrophe resulting in a significant proportion of premature deaths. From records of global mortality, it is the second cause of death globally. One in six global death is due to cancer (WHO, 2018). Records also shows that cancer is the leading cause of death in high income or developed countries (Stringhini, 2018). It is the third cause of deaths in low-medium income or developing countries (Saibu et al., 2017). Furthermore, an estimated 70% of global cancer deaths occurs in developing countries.

Despite progress in cancer awareness in the aim to fight cancer, both high income or developed and low-medium income or developing countries will experience continues increase in cancer occurrences as predicated report shows that the number of new cancer cases will continue to increase throughout the coming years and may exceed 20 million by the year 2025 (Boivin et al., 1995). The burden of cancer on victims result in adverse physical as well as psychosocial implications that could possibly result from the cancer itself or through the course of treating it (Holm, 2013). According to Fitzmaurice (2017), cancer has resulted in more than 200 million disability-adjusted life years globally. Casualties from cancer is not only from deaths, or disabilities, the consequences may also come in the form of financial bankruptcy, body toxicity, serious short term and (or) long term side effects, as well as introduction of new health problems leading to complications.

One of the challenges in tackling global burden of cancer is lack of available resources required for early screening/diagnosis. However, this is not a serious problem in high income or developed countries as the fight against cancer is in advance level and there has been record breaking achievement in reducing mortality rate and increasing survivorship for most cancers.

This was achieved through constant cancer research, establishment of comprehensive and standard cancer centers, awareness creation, as well as huge financial support from national and international bodies etc. The situation is grossly different in low-medium income or developing countries where the increasing incidence rate of cancer is given little to no attention resulting in very high mortality rate. Most victims of cancer in Nigeria are unaware of the disease for a long period of time which may kill them slowly or prematurely and the ones who are able to make it to screening centers for diagnosis find out their cancer have reached advanced stages, when little to nothing can be done to improve their life quality and predict survival. In addition to these, there is very poor registry of incidence, mortality, and survival rate of cancer cases in Nigeria, the readily available data are usually estimations made by large international organizations.

Cancer care (screening, diagnosis, treatment, and palliative care) requires the collective duty of specialize medical professionals particularly oncologists, primary care physicians, surgeons, nurses, pharmacist and rehabilitation physicians etc. According to Yang (2014), the world should anticipate shortage of more than 2,300 oncologists by the year 2025 if effective and efficient action is not taken (Mathew, 2018). Furthermore, the challenges of cancer also transcend to the nature and complexity of cancer itself. Cancer grows uncontrollably and this could mean that cells are produced more than they are killed and vice versa. Different patients may respond differently to treatments and associated side effects depending on their age, gender, and other factors. Because of this variability, the treatment of cancer from one patient to another may be differ. It becomes quite difficult or risky to decide the right treatment techniques for specific patients. Also, the prediction of the associated benefits and risks for each therapy is also hard to reach, and lastly, the fragmented nature of the cancer care system (Institute of Medicine (IOM), 1999) also presents challenges that may impede coordinated care and the development of comprehensive treatment plans (Patlak et al., 2011).

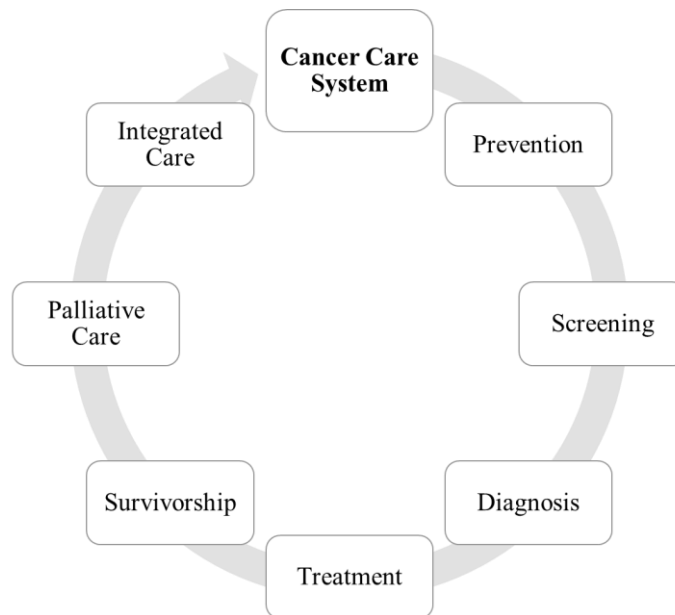
## **1.2. Standard Cancer Care System**

Progress against cancer must involve the establishment and implementation of a standard cancer system including national cancer control programs/policies, cancer centers etc. that must improve prevention, early screening and diagnosis, treatment, palliation and general quality of

life of cancer patients. A standard cancer care system must be established based on a nation's population, the prevalence and aggressiveness of cancer, and the availability of both financial and human resources etc. According to Gospodarowicz et al (2015), a comprehensive and standard cancer care system must include a set of specialized and detailed functions required for the effectiveness and efficiency of the system. These functions comprise of national cancer control program or population-based cancer plans, functioning cancer registry in all hospitals and other healthcare facilities, healthcare system that includes all level of clinical cancer care, as well as public health functions etc. Figure 1.1 shows the sequential arrangement of parameters required for successful cancer care system. The standard cancer care system its self might only function effectively if the health system and the government of such country is supportive. A country's highest governing health institution such as the United States Department of Health & Human Services (HHS) and the federal ministry of health Nigeria are the principle healthcare policy makers and must therefore be obliged to formulate and implement cancer care policies that will improve the cases of cancer for the general population of the country.

Cancer center can be considered as a power house within a healthcare institution needed for the fight against cancer. Inside a cancer center is where the oncologists are, the screening and diagnosis machine, the research units dedicated for discovering or inventing new and improved approaches of preventing, screening and diagnosing, treating, as well as providing palliative care (with minimal risks/side effects and if possible, cost effective). The cancer centers also function to provide cancer awareness by educating the populace of the various risks factors of cancer depending on age, environment, occupation, genetic history, diet and lifestyle etc. although cancer centers are complex and may require large finance to establish, it can still be established and supported by any nation, city, or even town regardless of their level of resources. This is because cancer centers are critical to delivering cancer care and actualizing the goals and objectives (clinical functions) of a standard cancer care system.





**Figure 1.1:** Parameters of cancer care in sequential order

### 1.3. Fuzzy PROMETHEE

Because of the complex variable nature of cancer, treatment from one patient to another may significantly differ. It becomes quite difficult or risky to decide the right treatment techniques for specific patients and the prediction of the associated benefits and risks for each patient is also hard. The use of computer aided diagnosis CAD such as neural network, mathematical models, and various artificial intelligence approaches is capable of assisting medical oncologists with faster and effective patient specific diagnosis. Fuzzy promethee, a multi criteria decision making theory (MCDM) is a new user-friendly approach that can be applied in various uses in the fight against cancer. For example, it has been used to comparatively analyze various cancer therapy techniques, reconstruction algorithms, cancer treatment centers, cancer treatment devices etc. based on vital parameters. This thesis uses fuzzy promethee to compare the level or progress of cancer care in Nigeria to some selected countries including India, Australia, Turkey, USA, and the UK.

Fuzzy promethee is the fusion of the concept of fuzzy logic and promethee in order to achieve an effective decision goal. Fuzzy logic is a form of multi-valued logic that allow intermediate values in the form of multi-valued logic, in which the truth values of variables maybe any number between 0 and 1. Fuzzy logic is distinct in concept due to different interpretations involved where binary sets have true or false valued logic. The variables may have a truth-value that ranges in degree, where the truth values can range between completely true and completely false. The idea of fuzzy Promethee is achieved from the fusion of fuzzy logic and promethee together. Fuzzy logic can be defined as a class of multi-valued logic that permit intermediate values in form of multi-valued logic, in which the truth values of variables maybe any number between 0 and 1 i.e., the truth values are obtained in degrees ranging between completely true to completely false. Fuzzy logic systems are applied to design process to enhance efficiency and simplicity.

Promethee (Preference Ranking Organization Method for Enrichment Evaluations) on the other hand, is a multi criteria decision making (MCDM) technique used in diverse fields of study. It mutually compares related alternatives with regards to their related and selected criteria. Promethee is quite more advantageous compared to other MCDM techniques due to its efficiency and easiness in concepts and applications. It is characterized by its user-friendly procedures. The concept of promethee was first conceived by Brans et al. (1985) which was further developed in 1986 by the same authors. The concept of promethee is based on the mutual comparative analysis of alternative pairs with regards to each criterion selected by the user/researcher.

The concept of fuzzy logic and promethee (fuzzypromethee) has been employed as a method for this study because it has been shown to effectively compare related alternatives that have criteria as fuzzy value or the weight of the criterion is defined as a linguistic data. Some of the earliest studies that used this methodology include Goumas and Lygerou (2000), Ozgen et al. (2000), Geldermann et al. (2000), Ulengin et al. (2001), Bilsel (2006), Chou et al. (2007), Tuzkaya et al. (2010). Recent studies that incorporated the idea of fuzzy and promethee include the studies of Uzun Ozsahin et al (2017), Uzun Ozsahin et al (2018), Uzun Ozsahin et al (2019),

and Isa (2018). All of these studies made effective comparative analysis of related alternatives in various fields depending on the necessary criteria and importance weight of the criterion.

In the initiation of the process of promethee, only two important information are required. Firstly, the information on the weight of selected criteria to be analyzed. Secondly, the user/researcher's preference function that would be used for the comparative analysis of the alternative in regards to each of the criteria selected (Macharis et al., 2004). There are six different functions that a user/researcher can choose from; usual function, U-shape function, V-shape function, level function, linear function and Gaussian function. These preference functions are used to define different criteria. In a better explanation, the preference function denotes every difference between the analysis obtained for two alternatives (a and b) for a given criterion, within a preference degree ranging from 0 to 1.

The main aim of the Fuzzy PROMETHEE model was proposing a comparison between two fuzzy sets. For this aim, Yager (1981) found an index, which is determined with the center of weight of the surface of the membership function to compare the fuzzy numbers. Yager (1981) define the magnitude of a triangular fuzzy numbers corresponding to center of triangular with the  $YI = (3n-a+b)/3$  formula. In our F- PROMETHEE application, we will apply to Yager index.

#### **1.4. Statement of Problem**

Cancer over the years in Nigeria has claimed millions of lives. Today, it is claiming hundreds of thousands of lives. In 2018, the incidence rate of cancer was estimated at 1171122 new cases (Globocan, 2018). Incidence rate of cancer in Nigeria is 191.6 per 10000. The mortality incidence ratio of cancer in the country is higher than any African country and higher than most countries in the world (Nigeria National Cancer Control Plan, 2018). For instance, 29 blood cancer deaths per 30 blood cancer cases in Nigeria compare to India, another developing country who has 99% survival rate for blood cancer (Muanya et al., 2018). In the united states, the mortality rate of breast cancer is 19% making the survivorship 81%, however these rates in Nigeria are 51% and 49% for mortality and survivorship respectively (Nigeria National Cancer Control Plan, 2018).

The poor awareness and perception of cancer in Nigeria are key contributing factors. Studies have shown that there are hundreds of Nigerians who are suffering with cancer and some are totally unaware of their sources of pain and suffering that is leading to low quality of live and eventually death. Some of the major and critical factors challenging the status of cancer care include poor government funding, health system, poor and inadequate cancer centers, cancer registries, available drugs and treatment centers, high level of poverty, lack of specialized and oncologists, clinical engineers, nurses and other medical specialist, as well as lack of general management and accountability at every level, therefore Nigeria needs standard system of cancer care customized to the locality, awareness, and increase affordability of cancer care services.

### **1.5. Aims and Objectives**

The aim of my thesis is to critically and comprehensively evaluate the condition and quality of cancer care in Nigeria and a comparative analysis with top cancer treatment destinations under such parameters. The thesis will propose a customized standard model for cancer care in Nigeria, and recommends ways in which challenges affecting cancer care can be solved. The following objectives will be considered in the thesis;

1. To review the level of awareness and perception of cancer in Nigeria
2. To review the national cancer program for 2018
3. To recommend direct and indirect funding sources
4. To recommend ways affordability of cancer care services can be administered to middle- and low-income patients in the country.

### **1.6. Research Question**

The following are research questions that my thesis intends to tackle;

1. What is the status of cancer care in Nigeria?
2. Does Nigeria have a standard cancer care system?

3. Why is do Nigeria have poor cancer registry and data?
4. How can cancer care services be made affordable for middle- and low-income patients in Nigeria?

### **1.7. Methodology**

The thesis consists of both qualitative and quantitative research methods. The qualitative research method involves the comprehensive review of secondary data regarding the state of cancer care in Nigeria and a review of the standard cancer care system established by Gospodarowicz, et al., (2015). From these reviews, a new standard cancer system will be established and customized to the case of Nigerian cancer taking in to consideration several local factors such as incidence, mortality and survival rate, risk factors, economic status of majority of Nigeria (if possible economic status of most cancer patients in the country), medical human resources, and the economic status and cancer budgeting in the country etc.

The quantitative research methods on the other hand involves the utilization of the excellent decision making and user friendliness of fuzzy promethee to comparatively analyze cancer care in Nigeria to top cancer treatment destinations in Africa and around the world including India, United states, Turkey, Australia, and the United Kingdom. Vital parameters such as average cost of treatment, 5 year relative survival rate, doctors to patient ratio (DPR), security/safety/peace, clinical services & research, availability of clinical oncologists, ratio of new cancer incidence to an oncologist, number of cancer centers, quality of health systems, population, welcoming countries rank and tourism opportunities. Afterwards, linguistic fuzzy scale of preference (triangular fuzzy linguistic scale) was analyzed to choose which criteria were more important than others and to obtain the importance weight of each criterion value. The yager index was used to de-fuzzify each parameter values. Lastly, the de-fuzzified values will be imputed in to PROMETHEE GAIA decision lab software with Gaussian preference function for the comparative analysis of Nigerian cancer care and top alternative cancer treatment destinations.

### **1.8. Significance of the Study**

This study was not intended to present the situation of Nigeria positively, it was intended to portray the condition of cancer care in Nigeria truthfully. The current Nigeria's National Cancer Control Plan (2018) was established, however, data as old as 2012 was used in the process which is not helpful in dealing with the pandemic level of cancer in the country. Therefore, this study is useful because it compiles most recent cancer data and statistics from 2018 and 2019 to increase awareness on cancer cases today and the prediction for future which will need an effective and efficient cancer care systems that is customized based on the needs and available resources in the country. This thesis can be referred to as a study of what is there, what is not, and what can be done about cancer care in my country Nigeria.

### **1.9. Limitations of the Study**

One of the major limitation in this studies is lack of primary data which will require a lot of financial support and time to travel throughout Nigeria to gather data from cancer registries such as those in Ibadan, Abuja, Kano, Calabar, Lagos etc., to observe the level of cancer care and services in Nigerian hospitals and cancer centers as well as gather data from the federal ministry of health. Another limitation is the time frame of the thesis which was conducted only during the summer period (1 month).

### **1.10. Organization of the study**

In this thesis, six chapters is included. Each chapter provides comprehensive information accordingly. Chapter one covers the introduction which consist of subsections such as the background of study, introduction to standard cancer care system, introduction to fuzzy promethee, statement of problem, aims and objectives, research questions, methodology, significance of study, timeline of study as well as limitation of study. A detailed literature review of global, regional and national cancer burden is presented in chapter two comprising of the following subsections; cancer in the world, cancer in developing countries, and cancer in Nigeria. The chapter also provides literature review for fuzzy promethee. Chapter three present the comprehensive cancer system taking to consideration the various parameters required for a standard model to function effectively and efficiently. It includes the following subsections;

comprehensive and standard cancer treatment model and affordability of cancer care. In chapter four, the methodology used in this thesis is discussed in full. Furthermore, chapter five presents the findings and discussion from fuzzy prometee application, the proposed standard model customized for Nigeria, discuss the ways cancer care can be made affordable for the middle- and low-income Nigerians and how funding can be optimized for cancer care in the country. Lastly, chapter six present the conclusion and recommendation of my thesis.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1. Cancer in the World

The world is experiencing a continues increase in the number of new cancer cases affecting a large population of people around the world. The estimated number of new cancer cases in 2008 was 12.7 million while the total number of recorded cancer deaths was 7.6 million (Ferlay, et al, 2014). There was a slight increase in these figures for the year 2013 and 2015 with an estimated new cases of 14.9 million and more than 8.6 million deaths (Ferlay, et al, 2014; Stewart, 2016). In 2012, Globocan estimated that the world has 32.6 million people who have cancer. The report also showed that there were 14.1 million recorded new cases of cancer and more than 8 million cancer patients have died from the disease (Globocan, 2012).

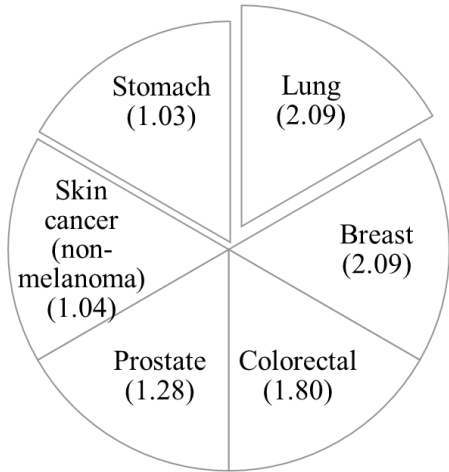
In 2018, the latest estimates of global condition of cancer showed an increase in new cancer cases from 14.1 million in 2012, to 18.1 million in 2018 and an increase in cancer death from 8.2 million in 2012, to 9.6 million in 2018 as well as an estimated 5-year prevalence was 43.8 million people living with cancer (Globocan database, 2018 accessed from IARC Global Cancer Observatory).The annual number of recorded cancer deaths is approximately 8.8 million which exceeds the number of deaths by a combination of tuberculosis, HIV/AIDS, and malaria (Prager et al, 2018).

In respect to the standard cancer incidence rate (SCIR), it has been found that men have 25% higher rate (205 per 100,000) compared to women (165 per 100,000). The incidence rate in men also has a wide variation in regards to regions of the world compared to the incidence rate of women. For instance, incidence rate in women in South-Central Asia is reported to be 103 per 100,000 while the case in Northern America is 295 per 100,000 which is almost three-fold. However, men cancer incidence rate in the west of Africa is 79 per 100,000 while in Australia and New Zealand, the incidence rate is 365 per 100,000 which is almost five-fold (Nigeria National Cancer Control Plan, 2018).

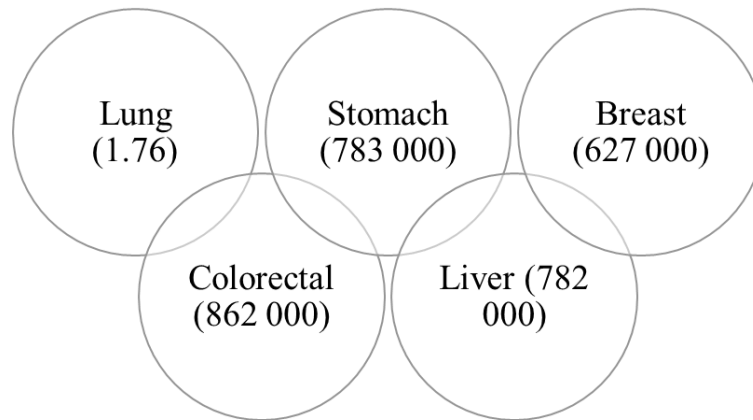


According to World Health Organization (WHO) fact sheet report of 2017, the estimated figures of cancer cases over the duration of the next two decades will increase to about 70%. Accordingly, cancer is the leading cause of morbidity and mortality globally, in fact, it is ranked the second cause of the death around the world making 12.5% of all deaths (Saibu et al, 2017). The most common cancer in the world today is lung cancer followed by breast (25%), colorectal, prostate, skin, and stomach cancer. The top cancers causing deaths in descending order include lung, colorectal, stomach, liver (9.1%), and breast cancer.

Figure 1.1 and Figure 1.2 shows the global trending new cases of cancer and the leading cancer deaths respectively.



**Figure 2.1:** Global trending new cases of cancer 2018 in millions (WHO, 2018)



**Figure 2.2:** Leading causes of cancer deaths 2018 in millions (WHO, 2018)

The consequence of these cancer figures is experienced by millions of cancer patients and their family/friends either physically (susceptibility to various illnesses, prolonged disability, and premature mortality etc.), financially (personal bankruptcy, debt burden from direct and indirect costs), as well as emotionally. The estimated annual global economic burden of cancer for the year 2010 was US\$ 1.16 trillion (Stewart et al., 2014). According to Prager et al. (2018), the year 2020 will have an estimated 10% (exceeding \$150 billion) increase in cost of oncology services. Majority of cancer patients globally and almost all governments find it difficult to handle the economic challenge of cancer care. In developed nations, there is without doubt high quality cancer care services with promising survival rate however, these are not affordable to the cancer patients since cancer as an unpredictable disease result in devastating economic consequence in the form of high cost tests, treatments and care which may be required for several years (Thomas et al., 2015). In fact, the world health organization has indicated that 90% of developed countries have readily available cancer treatment services while only 30% is available in developing countries.

Some of the vital challenges affecting cancer care around the world is lack of effective and efficient health system, high cost, early and poor screening, inadequate national prevention and

control programs, inadequate international funding, awareness and perception of cancer, as well as lack of prioritization by responsible bodies at all levels.

## **2.2. Cancer in Developing Countries**

The burden of cancer hits developing countries the most. Most developing countries are located in Africa, south America, and the middle east with a total of 126 countries and billions of populations (World Population Review, 2019). According to a report by Globocan in 2012, developing countries have an estimated 8 million number of new cancer cases, 5.3 million deaths caused by cancer and 15.6 million people living with cancer which in percentage is 57%, 65% and 48% respectively (Nigeria National Cancer Control Plan, 2018). A study in 2017 shows a linearly increasing mortality rate of cancer with about 75% of the world cancer deaths recorded in developing countries (Prager, 2018). The report also shows that there is a rapidly increasing number of new cancer cases in developing countries compared to the developed world.

In Africa, there is little to nothing being done about the alarming linear growth of cancer. In 2004, cancer was reported to be the 7<sup>th</sup> leading cause of total deaths. Estimation for the future also shows that the pandemic level of cancer in the continent will only continue increase with an estimated 1.28 million new cancer cases in 2030 and 970,000 cancer deaths (Ferlay, et al, 2014). Recent report by Globocan in 2018 shows that Africa has 1 055 172 new cancer cases, 693 487 mortality rate and 1 930912 5 years prevalence. West Africa has 229459 new cancer cases (90232 in men and 139227) while the mortality rate was 153332 (63968 for men and 89364 for women) (Globocan, 2018). Despite these disturbing statistics, no standard policy has been established by the African union AU to tackle the disease in the continent (Saibu et al., 2017).

Some of the major challenges affecting effective and efficient cancer care delivery in developing countries include the following; age and obesity factor, environmental and demographic factors, increase industrialization exposing more people to risk factors, poor health systems, lack of effective clinical management, lack of awareness and the perception of cancer, financial support and medical human resources etc. Despite increasing and alarming growth in cancer incidence and mortality rate in developing countries, very little is being done in both national and

international levels. Ferlay, et al (2014) indicated only 5% of international budgetary allocation is awarded to developing countries to fight cancer. Hence developing countries are not well prepared and equipped to handle the pandemic level of cancer (Prager, 2018).

### **2.3. Cancer in Nigeria**

Nigeria is among the list of developing countries with an estimated population of 200,963,599 (2.6% of the world) in 2019 and economic growth rate of 2.60% (World Population Review, 2019; worldometers, 2019). The estimated population released by the National Population Commission of Nigeria (NPC) is 198 million and with annual growth rate of 3.5%, the population is estimated to reach 400 million by the year 2050 (Adebajo, 2019). The cancer burden, its consequences and future outlook in Nigeria cannot be overestimated. Cancer over the years in Nigeria has claimed millions of lives. Today, it is claiming hundreds of thousands of lives. Although there is a wide gap between the rich and the poor in the country, the devastating consequences of cancer is affecting Nigerians regardless of their economic status in the country.

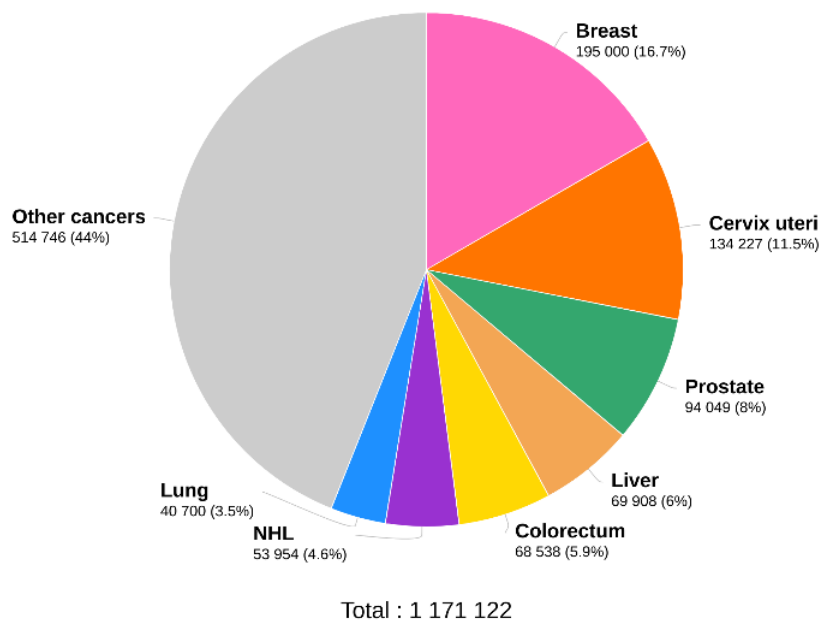
According to Njaka (2016), cancer have claimed the lives of prominent Nigerians including Mr. Yinka Craig, Mrs. Alarere Alaibe, Mr. Sonny Okosuns, Ms. Tyna Onwudiwe Oputa etc. However, there are several thousands of poor and moderate Nigerians who died prematurely from cancer due to lack of finance and who had started treatment and became bankrupt. The lack of awareness and perception of cancer in Nigeria are key contributing factors. Studies have shown that there are hundreds of Nigerians who are suffering from cancer and are totally unaware of their source of pain and suffering that is leading to death. The lack of effectively and efficiently equipped screening and diagnostic cancers that is needed for early detection are very critical challenges in the country.

#### **2.3.1. Trend in Cancer Incidence in Nigeria**

Through the years, the trend in incidence rate of cancer in Nigeria just like any other developing country is at constant increase. For the year period 1960 to 1969 and 1978, records from Ibadan cancer registry have shown cancer incidence by age standardized rates was 183.1 and 140.4 per 100000 population respectively (Njaka, 2016). The cancer cases found in the records retrieved

from Zaria cancer registry for the year period 1976 to 1978 shows 1575 new cases. In 1992, data from the world health organization estimated that there were an annual 100,000 new cancer cases. There were 2819 new cancer cases according to the records from Jos cancer registry for the year period of 1995 to 2002. Estimation for the year period from 2004 to 2006 from Calabar registry shows new cancer incidence of 588.

Future prediction observed during the year 2001 to 2005 shows that cancer incidence will be at the rate of 196.7 per 100000 people (Njaka, 2016). The report for 2011 shows 200000 new cancer cases. According to Globocan, incidence for all ages was estimated at 10279 in 2012 (Saibu et al, 2017). Prediction shows 500,000 annual new cancer cases in 2015 (Njaka, 2016). In 2018, the incidence rate of cancer was estimated at 1171122 new cases (Globocan, 2018). Incidence rate in Nigeria is 191.6 per 10000. Nigeria is home to 50% of Africa’s new cancer cases according to Oxford journal, annals of oncology. The 5-year cancer prevalence in Nigeria was estimated to be 211052. Figure 2.3 shows cancer incidence in Nigeria



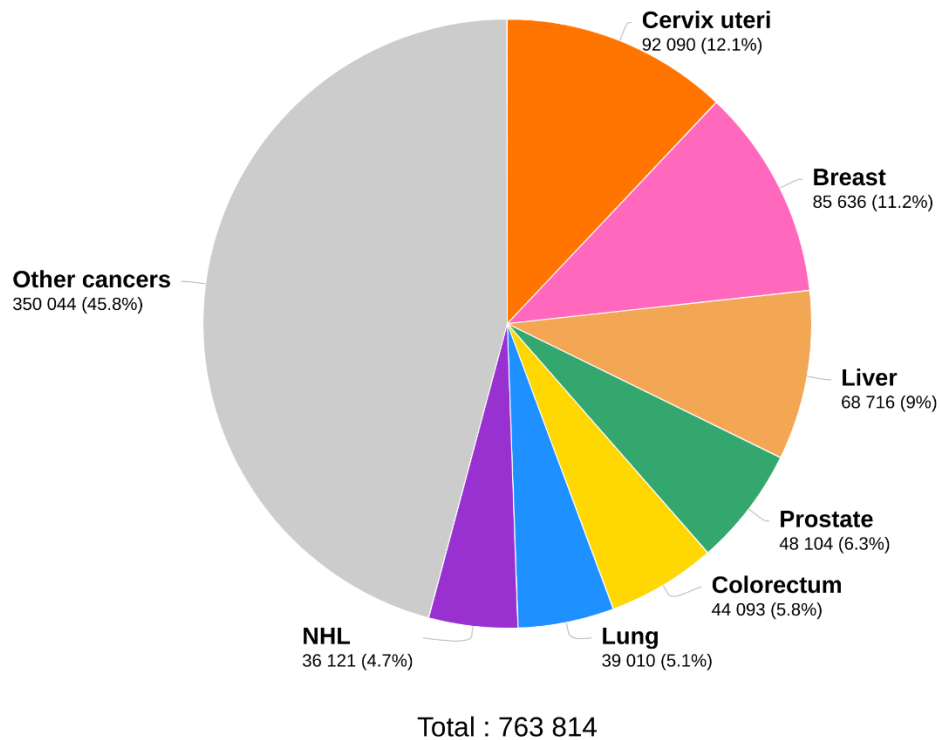
**Figure 2.3:** Estimated number of new cancer cases in Nigeria 2018 (Globocan, 2018)

### **2.3.2. Cancer mortality and Survivorship in Nigeria**

The mortality rate of cancer in Nigeria according to WHO is 148.2 per 100000 (Njaka, 2016). Claims have been made that the country has one of the highest levels of cancer mortality in the world. Report shows that four patients out of five die from cancer. That means from the 1000 cases of cancer in Nigeria, 805 of them die. There are also 10 deaths resulting from cancer per hour and 240 deaths per day (ICIR, 2019). In 2017, WHO reported about 70,327 cancer patients have died from the disease (Iwenwanne, 2019).

In 2018, Globocan estimated that there was a total of 763814 cancer deaths recorded in Nigeria. Figure 2.4 shows estimated deaths by cancer in Nigeria shows the mortality of different cancers in Nigeria. Furthermore, breast cancer kills Nigerian women per hour according to Nigerian branch of the Committee Encouraging Corporate Philanthropy (CECP) with 24 deaths of women every 24 hours from cervical and liver cancer and 12 deaths from colon cancer every 24 hours. On a daily basis, there are 30 female breast cancer deaths, 14 deaths from prostate cancer.

One of the brutal mortality rates of cancer in Nigeria according to CECP is blood cancer where there is one survivor for every 30 cases (Saibu et al., 2018). The mortality incidence ratio of cancer in the country is higher than any African country and than most countries in the world (Nigeria National Cancer Control Plan, 2018). For instance, 29 blood cancer deaths per 30 blood cancer cases in Nigeria compare to India, another developing country who has 99% survival rate for blood cancer (Saibu et al., 2018). In the united states, the mortality rate of breast cancer is 19% making the survivorship 81%, however these rates in Nigeria are 51% and 49% for mortality and survivorship respectively (Nigeria National Cancer Control Plan, 2018).



**Figure 2.4:** Estimated number of total cancer deaths in Nigeria 2018 (Globocan, 2018)

### 2.3.3. Trending Cancer by Type in Nigeria

According to the global and regional report data released by WHO for 2018 which shows that the total number of new cancer cases in Nigeria was around 1171122. The top five trending cancer in Nigeria including breast, Cervix uter, prostate, Non-Hodgkin lymphoma, and liver cancer are discussed accordingly. Breast cancer was the number one trending cancer for new cases and it is also number one for cancer mortality. There was 26310 (22.7) recorded news cases (22.7% of all cancer), and 11564 deaths (16.4% of all cancer). The cumulative risk for both new cases and mortality was 4.33 and 2.01 respectively. The 5-year prevalence for breast cancer in Nigeria is 52562 which makes the probability of developing cancer during this period at 54.41.

The second trending cancer in Nigeria for the year 2018 is Cervix uter cancer. It has a total number of 14943 for new cases (12.9%) with a cumulative risk of 3.27. moreover, the mortality

from Cervix uter cancer is 10403 (14.8%) with a cumulative risk of 2.50. the estimated 5 years prevalence is 29 601 with a probability of 30.64. The third trending cancer in the country is Prostate cancer which has total number of 13078 new cases (11.3%) with a cumulative risk of 4.14. Prostate cancer has 5806 (8.3%) mortality with a cumulative risk of 1.78. The five-year prevalence is 19609 making the probability of developing cancer 19.75. The fourth trending cancer in Nigeria is Non-Hodgkin lymphoma which as 5367 total number of new cancer cases (4.6%) with a cumulative risk of 0.48. the mortality for this cancer in 2018 is estimated at 3726 (5.3%) with a cumulative risk of 0.40. on the other hand, the 5-year prevalence of the cancer is 10612 which brings the probability at 5.42.

Lastly, the fifth trending cancer in Nigeria is cancer of the Liver. In 2018, there was 5129 (4.4%) record of new cases with a cumulative risk of 0.54. The mortality was recorded at 5154 (7.3%) with a cumulative risk of 0.55. the estimated five-year prevalence of liver cancer is 4849 which makes the probability at 2.48. Table 2.1 shows the total types of cancer that was recorded in Nigeria including the ranking in terms of incidence and mortality (WHO, 2018). Trending cancer types in Nigerian men and women are presented in Table 2.2.

**Table 2.1:** Ranking of cancers in Nigeria in terms of the rate of incidence and mortality for the year 2018

<b>Cancer Type</b>	<b>Incidence Ranking</b>	<b>Mortality Ranking</b>
<b>Breast</b>	1	1
<b>Cervix uteri</b>	2	2
<b>Prostate</b>	3	3
<b>Non-Hodgkin lymphoma</b>	4	5
<b>Liver</b>	5	4



<b>Colon</b>	6	9
<b>Ovary</b>	7	8
<b>Rectum</b>	8	12
<b>Leukemia</b>	9	6
<b>Stomach</b>	10	7
<b>Brain, nervous system</b>	11	10
<b>Pancreas</b>	12	11
<b>Lung</b>	13	13
<b>Corpus uter</b>	14	19
<b>Larynx</b>	15	14
<b>Thyroid</b>	16	27
<b>Kidney</b>	17	18
<b>Nasopharynx</b>	18	15
<b>Bladder</b>	19	20
<b>Anus</b>	20	21
<b>Hodgkin lymphoma</b>	21	22
<b>Kaposi sarcoma</b>	22	24
<b>Lip, oral cavity</b>	23	16
<b>Multiple myeloma</b>	24	17
<b>Salivary glands</b>	25	25

<b>Esophagus</b>	26	23
<b>Melanoma of skin</b>	27	26
<b>Vulva</b>	28	32
<b>Gallbladder</b>	29	29
<b>Vagina</b>	30	31
<b>Oropharynx</b>	31	28
<b>Hypopharynx</b>	32	30
<b>Testis</b>	33	33
<b>Mesothelioma</b>	34	34

**Table 2.2:** Trending cancer types in Nigerian men and women

	<b>Men</b>	<b>Women</b>	<b>Both Gender</b>
<b>Population</b>	99 277 846	96 597 394	195 875 239
<b>New cases</b>	44 928	71 022	115 950
<b>Age-standardized incidence rate (World)</b>	89.1	119.4	103.8
<b>Risk of developing cancer before the age of 75 years (%)</b>	9.8	12.5	11.1
<b>Number of cancer deaths</b>	28 414	41 913	70 327

<b>Age-standardized mortality rate (World)</b>	60.4	75.5	67.7
<b>Risk of dying from cancer before the age of 75 years (%)</b>	6.5	8.4	7.4
<b>5-year prevalent cases</b>	74 284	136 768	211 052
<b>Top 5 most frequent cancers excluding non-melanoma skin cancer (ranked by cases)</b>	<ul style="list-style-type: none"> <li>✓ Prostate</li> <li>✓ Colorectum</li> <li>✓ Non-Hodgkin Lymphoma</li> <li>✓ Liver</li> <li>✓ Stomach</li> </ul>	<ul style="list-style-type: none"> <li>✓ Breast</li> <li>✓ Cervix uteri</li> <li>✓ Colorectum</li> <li>✓ Ovary</li> <li>✓ Non-Hodgkin lymphoma</li> </ul>	<ul style="list-style-type: none"> <li>✓ Breast</li> <li>✓ Cervix uteri</li> <li>✓ Prostate</li> <li>✓ Colorectum</li> <li>✓ Non-Hodgkin lymphoma</li> </ul>

#### 2.3.4. How Nigeria is handling cancer cases

The attitudes, efforts, attention and commitment towards the fight against the pandemic level of cancer and the improvement of cancer care in Nigeria is very poor. The government has poorly invested in medical infrastructure as is shown in the available treatment facilities which are inadequate for a large population of the country. In fact, report has shown that most cancer treatment facilities are unavailable to the large population of the country (Saibu et al., 2017). The very few treatment facilities procured by the federal government are usually old models which are no longer usable in many countries because they are considered obsolete due to improvement in healthcare through technological advancement. Also, these installed treatment facilities such as radiotherapy are not currently working due to the nonexistent habit of maintenance services of these facilities in Nigerian system, hence these facilities themselves need intervention before they can provide intervention to cancer patients.

In 2001, the Abuja declaration saw a joint agreement among African Union member states (AOU) about improving healthcare in their respective countries. They agreed they will increase annual healthcare allocation to 15 per cent of their national budgets, however most of them including Nigeria has failed to commit to this agreement (Iwenwanne, 2019).

In 2009, the wife of the then president, Umar Musa Yaradua, first lady Hajiya Turai Yaradua established an internationally accredited cancer center in the country (Njaka, 2016). It was not only the first in Nigeria, but in the entire west Africa. The vision of her initiative was to install state of the art screening, diagnostic, and treatment facilities which will be ran by a multidisciplinary team of professional medical workers to reduce cancer mortality and increase survivorship through cancer prevention, cancer education, training and research. However, after her tenure in office, the cancer center was left in jeopardy and it is currently not working at the pace it was intended to and the goals it was intended to achieve as statistics shows increasing rate of cancer incidence and mortality and very poor survivorship of general cancer (even the once that are easily treated). Furthermore, it is reported that there are only 9 cancer centers in Nigeria and that only 3 out of the 20 federal teaching hospitals in the country have diagnosing machines (Iwenwanne, 2019).

The perception of cancer in Nigeria is disturbing. Some of the reasons for this include lack of effective and efficient awareness and knowledge among population, poor medical facilities and health system, lack of multidisciplinary team of medical professionals, unavailability of drugs and the high cost associated with those available, to mention but a few (Njaka, 2016). A lot of people believe that a person with cancer has no chance of survival due to the poor level of available care and the cost associated with them. Most patients spend their entire life savings to for the available treatment. They end up dying after spending all their money leading to bankruptcy and debt burden on family members. People are uneducated on the need for early screening tests, and the high chance of survivorship when cancer is detected early and when treatment is also stated early. According to a report by vanguard news in 2012, about 60% of Nigerians do not seek orthodox medical care and more than 70% of the population are unaware of the improper treatment (Njaka, 2016).

Plan for a new national cancer control agency was announced in 2016. The new agency was dedicated for the cancer care programs including cancer research, diagnosis, treatment, palliative care, leadership and stewardship in Nigeria (Muanya and Ogune, 2018). It was to replace the functions of the national cancer control program/plan (NCCP) which was regulated by the Federal Ministry of Health. In 2018, a new national cancer control plan (NCCP) was established. In 2019, the national budget allocated for healthcare was 4.1% which was an increase from 3.9% national healthcare allocation in 2018 (Iwenwanne, 2019). The current government of president Muhammadu Buhari have continuously emphasized their commitment to improving the standard of cancer care through improvement and establishment of the facilities needed for cancer prevention, early diagnosis as well as treatment. As part of his commitment, a new cancer care center (NSIA-LUTH) was commissioned in 2019 at the Lagos state university teaching hospital (LUTH). The cancer center was an investment of \$11 million between the Nigeria Sovereign Investment Authority (NSIA) and LUTH. The center included cancer treatment machines such as linear accelerators (LINAC); brachytherapy machine, CT simulator, etc.

### **2.3.5. Challenges of Cancer Care in Nigeria**

Some of the major challenges of care in Nigeria is limitation of pathology, surgery, medical oncology, as well as radiation and palliation. These are some of the major contributing factors. Another major contributing factor is corruption which affects all spheres of Nigeria's development. It is very clear that the little budget allocated for cancer care and general health care services to the public is misappropriated by the so-called responsible ministers, directors and managers etc. Lack of facilities is another major challenge in the country. According to Iwenwanne (2019), Nigeria has a very limited social protection and statistics has shown that only approximately 5% of the general population are receiving treatment with health insurance, the other approximately 95% have no health insurance. This could be due to the poor economic status of most Nigerians and the unavailability of insurance services spread across the country.

Readily available qualified medical worker force is also lacking in the country and most of the highly qualified health professionals are often attracted by better paying and working conditions

abroad. The perception of Nigerian about cancer is nothing to write home about as well, people with the diseases are easily stigmatized or discriminated with most relating the symptoms of the disease to HIV (human immunodeficiency virus). For this reason, several victims of the disease hide in secrecy and present their cases in late stages. Moreover, there is a large population of cancer victims in the country who visit cancer centers (usually far from their city), however, the expensiveness of treatment is very high which most cannot afford, leading to personal bankruptcy, debt and premature deaths.

According to Njaka (2016), the reasons for poor outcomes in previous and current state of cancer care in Nigeria includes increasing and continuous exposure to cancer risk factors, late diagnosis, poor access to healthcare, poor equipped hospitals as well as perception of the people, however, Njaka indicated that affordability of treatment is another vital challenge. Availability of cancer drugs is poor, even the cheapest cancer drugs are not easily accessible by cancer patients in Nigeria. The available cancer drugs (usually expensive) are reserved for the rich class and the political class and not for public consumption (Njaka, 2016).

The most readily available data for the condition of cancer in Nigeria is based on estimates by WHO and other international bodies which is achieved by interpolation of data from few evidences based or populations-based cancer registries in Nigeria (Nigeria National System of Cancer Registries). Cancer registry in Nigeria is poor and its management is poorer. However, the estimations by WHO and other international organizations is probably not the accurate and precise reality of cancer situation in Nigeria, however, it shows alarming concern on the pandemic level of cancer cases in the country (Saibu et al., 2017).

#### **2.4. Fuzzy Promethee**

The concept of fuzzy logic and promethee (fuzzy promethee) has been employed by very few researchers. It has been shown to effectively compare related alternatives that have criteria as fuzzy value or the weight of the criterion is defined as a linguistic data. Some of the earliest studies that used this methodology include Goumas and Lygerou (2000), Ozgen et al. (2000), Geldermann et al. (2000), Ulengin et al. (2001), Bilsel (2006), Chou et al. (2007), Tuzkaya et al. (2010). Recent studies that incorporated the idea of fuzzy logic and promethee include the

studies of Uzun Ozsahin et al (2017), Uzun Ozsahin et al (2018), Uzun Ozsahin et al (2019), and Isa (2018). Additionally, more comparative studies using fuzzy promethee have been applied to in healthcare such as FUZZY PROMETHEE ANALYSIS OF LEUKEMIA TREATMENT TECHNIQUES; Fuzzy PROMETHEE for Ranking Pancreatic Cancer Treatment Techniques (Ozsahin et al., 2019), Evaluation of Sterilization Methods for Medical Devices (Taiwo et al., 2019), The Use of Fuzzy PROMETHEE Technique in Antiretroviral Combination Decision in Pediatric HIV Treatments (Uzun et al., 2019), Determination of Post-Exposure Prophylaxis Regimen in the Prevention of Potential Pediatric HIV-1 Infection by the Multi-criteria Decision Making Theory (Sayan et al., 2019), Selection of the Most Appropriate Antiretroviral Medication in Determined Aged Groups ( $\geq 3$  years) of HIV-1 Infected Children (Sultanoglu et al., 2019), and Deep Parkinson Disease Diagnosis: Stacked Auto-encoder (Al Shareef & Ozsahin, 2018). All of these studies made effective comparative analysis of related alternatives in various fields depending on the necessary criteria and importance weight of the criterion. There may be difficulty when we try to gather crisp data in a real-life situation in order to achieve optimal decision making. Therefore, when fuzzy logic is used, the decision maker is given the opportunity to define the problem using the crisp data under the vogue condition and is more realistic to handle.

## **2.5. Summary**

Tackling the pandemic level of cancer on the global scene and in Nigeria as a public health priority is a great challenge that requires effort and commitment towards prevention, treatment and survivorship in the long run. It is also important to take in to consideration the complex nature of cancer which doesn't always exist as a single disease, rather, it is associated with multitude of diseases. Additionally, several occurring cancer types are heterogeneous in nature and clinical research has shown that they consist of hundreds of histological and biological subtypes. This means that there are no cancers that are same and therefore different individuals with the same cancer type may exhibit different symptoms as well as react to treatment differently. Because of the complexity of cancer, there is great need for very specific and effective diagnostic as well as therapeutic measures. Several countries have advanced in to providing patient specific diagnosis and treatment. A multidisciplinary work force of qualified

and experience medical physicians, engineers, biochemist, pharmacists and so on is needed to implement diagnostic and treatment strategies in their individual and collective efforts to see that cancer patient care is achieved.

There are several international organizations such as WHO that have laid down guidelines, procedures and standards for cancer care services. According to Prager (2018), all these international standards are most effective when they are customized to the specific region, country or community. This is achieved through evidence or population-based research as well as epidemiology data for the most prevalent cancer types, readily available resources and other vital factors. Furthermore, the readily available resources must be properly allocated, and the establishment of accurate cancer registering for epidemiology data of the country's cancer. Although several countries have now established their national cancer control programs (NCCP), there is usually poor funding, and general implementation is not feasible especially in developing countries like Nigeria. In order to ensure that NCCP is successfully and effectively implemented, there need to be collective effort and contribution of all stakeholders, including health policymakers, academic organizations, healthcare professionals, civil society, patients, industry and the media because the status quo is not working (Prager, 2018).



## **CHAPTER 3**

### **THE STANDARD CANCER CARE**

#### **3.1. Introduction**

This chapter presents and discusses the framework for standard cancer care model established by Gospodarowicz and her team in 2015 to improve the quality of cancer patients lives at all stages of the disease. An effective and efficient standard cancer care system must include the establishment, integration and implementation of the following components in sequential order; prevention, screening, diagnosis, treatment, survivorship, palliative, and integrated care as shown in Figure 1.1. A standard cancer care system must be established based on the nations population, the prevalence and aggressiveness of cancer, and the availability of both financial and human resources etc.

According to Gospodarowicz et al (2015), a comprehensive and standard cancer care system must include a set of specialized and detailed functions required for effectiveness and efficiency of the system. These functions comprise of national cancer control program or population-based cancer plans, functioning cancer registry in all hospitals and other healthcare facilities, healthcare system that includes all level of clinical cancer care, as well as public health functions etc.

#### **3.2. A Comprehensive and Standard Cancer Care System**

According to WHO in 2000 and the work of Knaul et al in 2012, the framework for cancer care system must include the functions of stewardship, financing (budgeting and allocating resources), service delivery, and resource generation. More importantly, the leadership or responsible health institution of a given country should establish and implement national cancer plans otherwise known as population-based cancer control plan in order to not only provide screening, diagnosis and treatment of cancer, but also to create awareness on the prevention of cancer through education and other means of spreading awareness.

Therefore, a well-developed population-based cancer plan should include cancer registration system, general guideline and standard for practice and operation, compliance and

accountability, promoting and implementing research, creating awareness and cancer education, certifying and accrediting service providers, ensuring quality assurance, evaluating and monitoring system performance (Gospodarowicz et al., 2015). In general, the component of their proposed standard cancer care system is divided into clinical management, clinical services, and core services. However, their proposed framework focused more on clinical services which contains the cancer center. A center provides all the services required for the prevention, screening, diagnosis, treatment, survivorship, palliative and integrated care.

### **3.2.1. Clinical Management**

Clinical management is the first layer in a cancer system that provides patient specific clinical evidence-based assessment and decision making to individuals to determine the likelihood of cancer (screening) or diagnosis of cancer. It is a framework that is intended to assist both the medical practitioner and the patient in making effective decision (Hensher, Price and Adomakoh, 2006). Therefore, this layer based on personalized data provide individual clinical management plan that is reviewed by multidisciplinary team that manage the quality of the clinical decision based on evidence bases as well as the resultant outcomes from such decisions. After such assessment and an individual is found to have no cancer in his/her body, information such as risk factors will be provided for further prevention measures.

However, if an individual is diagnosed with cancer, the clinical management team will recommend the goals of care, appropriate interventions, and optimal time frames to such individual. These recommendations must be tailored based on the individual's evidence and consensus-based data. These include result from histopathologic/molecular diagnosis (e.g. biopsy) that present the specific type of cancer, the anatomical location and functional activity of the cancer (stage), and the size of cancer. The patient specific clinical recommendations also take in to consideration, an individual's characteristics such as gender, age, geographical location, risk factors, as well as genetic or family history etc.

As mentioned earlier, clinical management ensures that cancer patients are provided with defined goals of cancer care, intervention, treatment time frame as well as prognosis. A defined cancer care goal for a patient involves the cure for cancer and its control. Appropriate

psychological intervention is usually needed to reduce stress and anxiety during the course of treating cancer with the general aim of improving their quality of life as well as alleviating the symptoms and treating side effects. If the guidelines are not adhered to effectively, poor clinical decision may occur in the form of misdiagnosis (false positive and negative), which could either show absence of cancer while in actuality there is cancer in the individual's body and vice versa, hence they either are given cancer treatment inappropriate for their cancer situation (false positive), or they are receiving insufficient treatment/care that are poorly timed out and less effective due to false positive misdiagnosis. This has constituted to the reason for increased morbidity, disability, premature death and more costly health services.

Clinical management in a comprehensive cancer care system should include research centers or units where continuous research is observed to develop or improve guidelines for a wide range of cancer scenario. This can be done in collaboration with other professional, well equipped and well-funded organizations to achieve the goals of cancer treatment for reduced/controlled symptoms and side effects, increased survival rate, and general quality of life. These guidelines should be made compulsory after verification, in every healthcare institution (locally and nationally) that provides cancer care in the country, hence the role of stewardship. It is important to also not that these guidelines should include indications for the processes in medical imaging, biopsy, and other diagnostic approaches, as well as indications for the roles of nurses and other health professionals.

Prior to administration of cancer treatment to a patient, there are several structural and systematic review of the evidence base data of that patient as well as decided and alternative treatment plan as required by jurisdiction. According to the National Breast and Ovarian Cancer Centre (2008), the treatment of cancer for most patients requires multimodality, therefore, effective guidelines and standards must be put in place to avoid any kind of interference, complications and for effective decision making. In fact, a comprehensive and modern clinical management system must integrate the services of Multidisciplinary care teams as indicated by the National Cancer Action Team (2010), multidisciplinary clinics, and multidisciplinary cancer conferences. From evidence bases results, experience and professional knowledge of these team

of medical specialists, general guidelines for appropriate diagnostic test, treatment alternatives, and customized plan for individual patients are drawn (Cancer Care Ontario 2013a; National Cancer Action Team 2010).

As the condition of cancer continue to grow and become complex, the development of computer aided diagnosis CAD has been supporting and assisting medical radiologists to automate process that may consume a lot of time. Result from CAD systems show promising high sensitivity, specificity, accuracy, precision and minimal errors. Other fields of artificial intelligence have been growing significantly in decision making where support tools are established independently or incorporated to medical device/machines with the purpose to guide complex clinical management decision regarding the treatment of cancer patients. A very good example is the study carried out by some researchers at near east university to compare alternative prostate cancer therapy using a multicriteria decision making theory- promethee.

Of course, a comprehensive clinical management requires vast and readily available resources which requires funding or financing. According to Kerr and Midgley (2010), all clinical guidelines at all levels would require optimal resources to be successfully carried out, however, when such required resources are not available optimally, the guidelines can be adapted to the available resources in such scenario. Therefore, cost effectiveness is an important aspect to take care of when developing a clinical management guideline. This is in line with the opinion of Chalkidou et al., (2014) who said that organizers of guidelines should consider cost effectiveness while recommending or requesting funding. according to Strother et al. (2013), a country needs collective efforts, experience and expertise of clinicians to customize standard guideline to the local context taking in to consideration readily available resources.

### **3.2.2. Clinical Services**

After clinical management, the second layer of the cancer care system is clinical services. After decision are made based on evidence-based data, clinical services are there to implement or put these decisions in to action, within a time frame and deliver high quality treatment as much as possible. In other words, they are the service providers. As discussed in clinical management, most cancer patients require multimodality treatment plan such as a combination of services

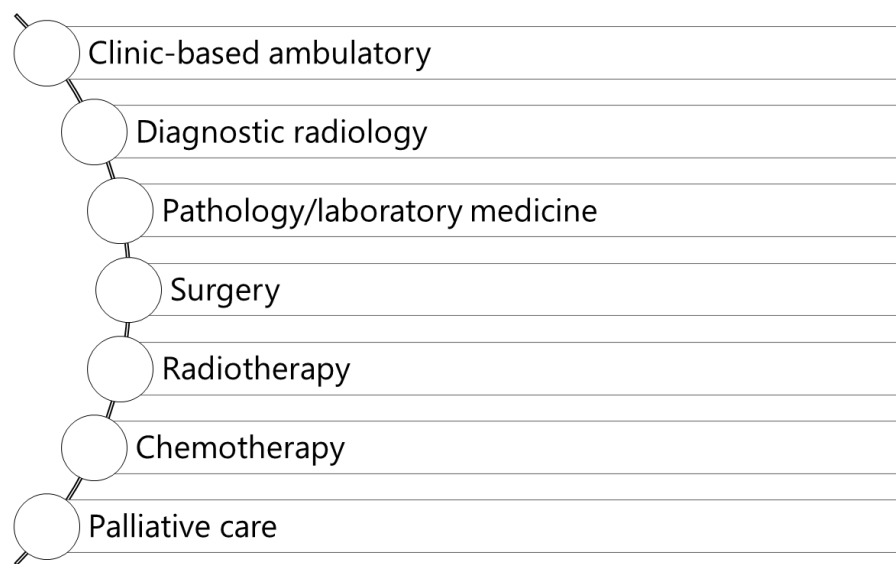
including laboratories and pathology, diagnostic imaging, surgery, systemic treatment/chemotherapy, and/or radiation, as well as pain management and supportive care.

All health care institutions that provide clinical services must have a well-equipped set of facilities, devices/machines, materials and human resources (both professional and nonprofessional), and guidelines (policies and procedures) required to guide a uniform process for the administration of diagnostic, treatment, and supportive care. The services of one step serves as prerequisite for another, the function of clinical services is to integrate these services for optimal performance if not the desired goals will not be achieved. For instance, the functions of screening, diagnosis, and treatment of cancer are related to each other and are sequentially prerequisites, that means the required goal of reducing mortality will not be realized when the quality of screening services do not meet the quality of diagnosis and treatment, also, the quality of diagnostic services should meet the quality of treatment services in order to achieve the desired goal of increasing survivorship.

According to the Canadian Partnership Against Cancer (2013), clinical services are so important in as much as they are considered the continuum of cancer control despite the lack of use of the services in a unidirectional manner (Knaul et al., 2012). Clinical services should be easily accessible to patients on time and in full range, this can help in early screening, diagnosis and high chance of cancer survival and general quality of life. On the other hand, when clinical services cannot be easily accessed, this will lead to cancer growing from one stage to another until it becomes too complicated or risky to the patient or even result to premature death.

Furthermore, quality is required for all clinical process at all levels. In a situation where clinicians observe incorrect or incomplete diagnosis (pathology and radiology results), this could result to either false positive or false negative which result to a complex emotional distress and cost for unnecessary services in the case of false positive result. However, when a patient incorrect or incomplete diagnosis result in false negative, the situation is even worst. This means there is a presence of cancer, that were not identified by the clinicians for optimal decision and treatment, and general cancer care. Hence, victims of poor clinical practices may be properly understood after the cancer has metastasized and has probably become unresponsive to

treatment options leading to unnecessary illness, disability, premature death, and costs to patients, their families, the health care system, and society. Therefore, it is important for all clinical services to be on time, accurate, effective and efficient. Clinical services also require special or general accreditation for the purpose of addressing the clinical services (such as safety for imaging and radiotherapy, external accreditation for laboratory services, and cell therapy), and service-specific credentialing bodies. Figure 3.1 shows the parameters needed for a comprehensive clinical service provision.



**Figure 3.1:** Parameters for a comprehensive clinical service for cancer patients

### *Clinic-based Ambulatory Care*

Clinic-based ambulatory care are official clinical settings that are usually the first point of clinical services that administer basic screening services (e.g. clinical interviews, physical examination, Pap smears, blood samples, or endoscopies) before further services by specialized medical professionals. Based on the activities, guidelines, and jurisdiction, the clinic-based ambulatory care offices should be equipped with necessary devices such as special examining tables for gynecologic malignancies, chairs and special endoscopic equipment for assessing head and neck cancers etc.

### *Diagnostic Radiology*

diagnostic radiology also known as biomedical imaging is the use of medical devices/machines to image a patient's whole or part of the body to determine the presence or absence of tumors. In the event of cancer occurrence, biomedical imaging procedure is not only capable of detecting the cancer, but it can also detect its location, the anatomical (size/location) and functional (stage and spread) data of the cancer. Imaging of the body is not only used for diagnosis; it is also used for treatment procedures e.g. real time imaging during radiotherapy to target only cancer cells and save neighboring healthy cells. In fact, the general function of cancer imaging also includes, assessment of therapy risks, side effects, complications, checkup for monitoring recurrence of cancer, and screening the general population for cancerous conditions etc. Biomedical imaging is very important especially for diagnosis.

The procedure of biopsy usually needs the guidelines of ultrasound imaging to collect epithelial cells from the surface of tumors. If not, there could be increased complication that may lead to misdiagnosis as is the case of cancer where improper biopsy procedures result in higher levels of PSA (prostate specific antigen) in the blood which is an indication of high possibility of prostate cancer. The use of ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI) for the purpose of embolization and tumor ablation is another important example. Some of the most popular imaging devices or machines include conventional x-rays, CT, MRI, single photon computed tomography (SPECT), Positron emission tomography (PET), and ultrasound etc. Several of these imaging innovations exist as multi modalities in order to maximize acquisition of patient data.

There are several specialists involved starting from biomedical/clinical engineers who are needed for procurement of effective imaging devices and managing them, radiologists, to biomedical technicians that services the medical devices to make sure they are at their best working condition at all times. A radiologist and radiologist technologists have dependent function in the radiology unit. The radiologist technologist is responsible for operating the imaging devices, image acquisition and application of appropriate reconstruction algorithm as well as assisting cancer patients during the whole scan procedure to minimize anxiety,

unnecessary models for accurate diagnosis. On the other hand, a radiologist is responsible for interpreting and making sense of the acquired images in to useful diagnostic information. All of these professions need guidelines within which they can operate individually or collectively to contribute to the general desired quality of cancer care.

Furthermore, safety is an essential consideration in all health institutions especially in the radiology unit where ionization radiation is the principle governing most medical imaging approaches. There are readily available safety standards, guidelines, and procedures for the effective establishment of radiology units, installation of medical imaging devices and how they should be operated including International Atomic Energy Agency, the International Society of Radiology, and WHO. One of the major achievements was the establishment of picture archiving and communication systems (PACS) and other web-based systems to help report and analyze medical imaging data in remote areas.

#### *Pathology and Laboratory Medicine*

The services of pathology and laboratory medicine are vital for patient specific analysis to generate evidence abased data needed for treatment plan. Biochemists and other pathologists acquire biological specimens or samples from individual patients for analysis to either confirm the presence and state of cancers using biological indicators (biomarkers) or to engineer biological agents to fight cancer etc. other functional services provided by laboratory medicine include pathology, hematology, biochemistry, microbiology, cytogenetic and molecular testing. There are several specialists involved in the operation of pathology and laboratory medicine. Several specialized and sophisticated medical machines, devices and instruments are essential for successful operation. These must also be managed by biomedical/clinical, bioengineers as well as services by the biomedical technicians within prescribed time frame. All of these processes must also be guided by common standards, guidelines, procedures, and must be accredited as well.

According to Gralow et al. (2012), a basic pathology should be able to provide services for specimen fixation, embedding into paraffin, tissue slicing, and staining; modern facilities must include immunohistochemistry, flow cytometry, as well as molecular and cytogenetic testing.



The inclusion of web-based systems (telepathology, a branch of telemedicine) is useful for reporting and analyzing data from remote areas of the world where there are little resources. This can be achieved through partnership with more comprehensive institution usually located in different cities or even a different country such as the network partnership between Ghana and Norway in a Breast Health Global Initiative (Masood et al., 2008). It is also important to note that various automation processes using the principles of artificial intelligence (CAD) is helpful for augmentation throughput and rapid reporting among networks.

### *Surgery*

Surgery is one of the safest and effective methods of treatment when cancer is detected at very early stage. It completely removes the tumor from the patient body. It is also used together with other therapy techniques for better results. It is also used to prevent the occurrence of cancer in precancerous body tissues of the patient such as mastectomy. Other functions include the diagnosis of cancer by biopsy, size and spread of cancer determination, reconstruction or restoration of function or appearance, survival and management of complications etc. (Gralow et al., 2012; Smith et al., 2013). Aside from being safe, another great advantage of surgery is that it is cost effective as studies shows that removal of precancerous body tissues for treatable cancer including cancer of the breast, cervical, and colorectal (Brown et al., 2006).

A surgical theatre needs several specialized and sophisticated medical devices and machines for successful surgical procedures. Surgical services include service needed from the point of decision for surgery, to the point of discharge of the patient from recovery room and the hospital as whole with quality as an integrating theme. Therefore, the surgical units must be well equipped with anesthesia devices/services, post-anesthetic recovery units, critical care or high dependency units, and frequently inpatient units for long term recovery. Cancer surgery procedures depends on some factors such as the type and stage of cancer, therefore, there should be general surgeons as well as specialty surgeons. In the surgical theater, a collective effort, knowledge, experience and expertise of surgeons, nurses, anesthesiologists, biomedical/clinical engineers, as well as other support staff is required for successful operation. For example, a biomedical/clinical engineer is need in case of fault in medical devices during the process. All

processes in the surgical unit must be observed under common standards, guidelines and procedures such as Surgical Safety Checklist for successful operation.

### *Radiotherapy*

Radiotherapy administer ionizing radiation to cancer cells to disturb their nucleus and eventually kill them. According to Gralow et al., (2012) and International Atomic Energy Agency IAEC (2003 and 2010), radiotherapy is use for treatment of cancer and in palliative care. External beam radiotherapy and brachytherapy (use of linear accelerators) are the two main approaches to radiotherapy. The importance of radiotherapy machine cannot be under estimated, apart from being cost effective, it can be used to treat thousands of cancer patients over a long period of time (Rodin et al., 2014).

Radiation therapists are usually responsible for the operation of radiotherapy machines on cancer patients, however, support from other medical workers may be required. A complete radiotherapy service is provided by a multispecialty team of radiotherapist and radiation oncologists etc. In establishing a radiotherapy unit, several standards, procedures, and guidelines need to adhered to for the safety of both clinician and patients (IAEC, 2008). This will also lead to the realization of the desired result. Such standards, procedures, and guidelines regarding the use of radiation and radioactive sources on patients may be established and regulated by national or international regulatory bodies. Some of the requirement for radiotherapy units include facilities such as patient, planning, treatment wards for the radiotherapy machines insulated with lead or other shielding materials, console for clinician safety, which should be aided by a nearby physics laboratory as well as quality assurance rooms.

### *Chemotherapy*

Systematic therapy is the use of drugs to kill cancer. This can be accomplished through intravenous and oral methods. The basic intention of systematic therapy is to reduce recurrence, improve survival and help preserve organs. Chemotherapy is the most popular systematic therapy, however other systematic therapy methods include hormone therapy, vaccine or immunotherapy and molecular targeted therapy. Although systematic therapy on its own is

effective in shrinking or killing cancer cells especially in early stage, in most cases, it is used in combination with other treatment methods like surgery, and radiotherapy for optimal achievement of destroying cancer (Gralow, et al, 2012; Livingston, 1997; Valentini et al,2010). For example, after surgery to remove cancer, hormone therapy may be used to shrink and eventually kill smaller tumors that could not be removed during surgery. Most hospitals and clinical centers have special ambulatory sections reserved for the administration of systematic therapy; however, the systematic therapy services can be performed in inpatient units since there is no radiation involved. In the case of specially designed ambulatory sections, it should be able to provide intravenous therapy, transfusions, minor procedures, such as bone marrow biopsies, thoracentesis, paracentesis, lumbar puncture, for cancer and noncancerous conditions.

Systematic therapy units are ran by medical oncologists in collaboration with specialized pharmacists, pharmacy technicians, and nurses. Of course, the use of drugs is helpful in the fight against cancer, however, complications associated with several risks may occur, therefore, systematic therapy must be coordinated by a set of guidelines, standards, and procedures that are accredited by national and international governing bodies. There are several challenges to the establishment and operation of systematic therapy units such as lack of specialized oncologists, and support services etc., however, cost is driving force that a lot of cancer patients are not able to afford.

### *Palliative Care*

Palliative care services are provided to cancer patients in order to generally improve their quality of life by managing the symptoms and side effects of cancer and other life-threatening diseases that may have developed during the process of treatment. Palliative care services are not only intended for the patient, it is also intended to ease the emotional pain of the family and friends of the patients. According to a comprehensive view of palliative care by WHO (2006), it is the provision of services that is aimed at preventing, relieving and managing suffering, provide early identification and assessment of symptoms, and address other physical, psychosocial, and spiritual issues. Most importantly, it should be provided in a timely manner and be done through the utilization of either pharmacologic and non-pharmacologic interventions.

The services provided by the palliative care team range from simple to very sophisticated services depending on the condition of the patient which depends on several factors such as age, stage of cancer, and complications etc. These services can be provided in a cancer center, general hospital, community clinic, hospice, or at home (Palliative Care Australia, 2005). According to Zimmermann et al. (2006), palliative care services is provided by medical physicians, nurses and support from other staff in the health sector. Just like any of the other clinical care services, palliative care must be coordinated by a set of guidelines, standards and procedures that are accredited.

Another important point is ethical issues in regards to nurses who take care of these patients. Pain management is an important part of palliative care. There are several approaches for relieving pain such as the use of cheap opioids and other pain relievers that are helpful to cancer patients. However, it is so disappointing to find that most cancer patients in developing countries do not have access to cheap opioids. In fact, report shows that 10% of poorest cancer patients suffer from pain cancer without using opioids per death (Knaul, Adami Adebamowo and others, 2012)

### **3.2.3. Core Services**

In a cancer center, core services include services of administration/management, human resources, information technology and management, physical facilities, pharmacy, infection prevention and control, quality assurance, finance and additional key supports, which operate individually and collectively to see to the success of clinical cancer services. All aspects of cancer core services must be coordinated by set of rules, standards, guidelines, procedures and must be accredited by national or international bodies. When cancer core services are well taken care of, the clinical services will be able to perform effectively and vice versa (Grimes et al., 2011). According to Mavalankhar et al. (2005), ineffective operation of core services will result in services being poor in quality, there will be inefficient use of available resources as well as a general resultant impact on the health of the patients.

### *Administration and Management*

Administrative management may be required in each aspect of cancer care which should be controlled by an apex administration. Administrative management is required because of the complexity of cancer care and the services it requires. This means aspect of the cancer care services has to be delivered and maintained according to guidelines and standards. The administrative management should be ran by skilled and accountable team. When there is better management in the cancer system, there is clarity in the road to achieving the goals and objectives of the system as well as better clinical outcomes and general quality of health for the patients (Carter et al., 2011). There are readily available frameworks for effective administration and management of cancer care system such as the framework presented by WHO (health manager) which contains information on how improvement can be made about management and delivery of health care services.

### *Human Resources*

Human resources for a cancer care system includes all workers directly or indirectly involved in the provision of cancer care to patients from the receptionists to appropriately trained and licensed oncologists. The human resources needed for successful operation of a cancer system consist of multidisciplinary team of workers who work individual and collectively in their roles to achieve the common goals and objectives of the system. Hence, they are very essential. The government of countries through the leadership of the cancer care system should make it a priority to train, license, recruit, retain clinicians, administrative and other workers related to cancer care. Works should also be provided opportunity to continue to develop and improve their knowledge and experience as well as become aware of trending approaches of cancer care and how they can be implemented.

The leaders should recruit the workforce by estimating the number of workers required for each of the centers in the country, identifying the roles and responsibilities of these workers including their positions required for the cancer care system, improving job satisfaction for workers by establishing effective and efficient compensation and benefit levels, analyzing individual as well as collective performance of the workforce, establishing a stewardship teams for management

and supervision of workers, and provision of conflict resolution services to the workers. Telemedicine services can also be incorporated as core human resources services to gain easy access to large information and assistance from the international clinical workforce.

### *Information Technology and Management*

The significance of information technology cannot be underestimated. It is necessary for effective implementation of telemedical services, managing of high volumes of information, informed safe, efficient, and effective care, and improve access. The concept of information technology implies the establishment of technological systems and their applications. A good example of an information technology system and their applications include computer hardware and software as well as telecommunication that gathers, stores, utilize, and share useful information. This means the operation of information technology is electronic based.

On the other hand, information management implies the organizations, linking, analyzation, and presentation of information for the purpose of encouraging guided decision. This means the operation of information management is not only electronic base, it can be done on papers or a combination of electronic base and paper base. Therefore, the cancer systems require the establishment and implementation of information technology and management in health records, operational systems, such as human resources, pharmacy, supplies, and equipment; financing; and other systems. As mentioned earlier, telemedicine is very crucial for linking a nation's cancer care system to the international community of clinical professionals, it requires the services of information technology which is also required for cancer care call centers or helpline (cell phones required for mHealth (mobile health)).

### *Physical Facilities*

The physical facilities house all the services administered by the clinicians and other workers to the patients. Hence it is very essential for effective performance of clinical services in cancer care centers. It includes the buildings which contains the internal areas like the reception or inpatient and outpatient rooms, ambulatory clinic space etc. it also includes facilities such as furniture, power supply, backup systems, waste disposal, electrical, mechanical, ventilation, and

plumbing systems. According to Debas et al. (2006), English et al. (2006), Hensher et al. (2006), and Gralow et al. (2012), health care services or cancer care systems that possess high physical facilities tend to maximize their healthcare resources in a situation where they are centralized in a few facilities. Most importantly, these facilities need to be operated by workers in such a way that is at sufficient capacity in order to ensure efficiencies of scale (Mills et al., 2006).

### *Pharmacy Services*

Pharmacy services are very essential in the administration of drugs at all levels of cancer care ranging from simple pain killers to complex chemotherapy drugs etc. the pharmacy unit of a cancer center should ensure safety and administration of effective medicine to patients. According to the American Society of Health System Pharmacists (2013), some of the functions of pharmacy include managing practice; policies on medication use; optimizing medication therapy; procuring drug products and managing inventory; preparing, packaging, and labeling medications; delivering medications; monitoring medication use; evaluating the effectiveness of the medication-use system; and conducting research. Pharmacists must be appropriately trained about medication useful for cancer care (including complication, side effects, as well as drug toxicities) and they must be licensed by the national bodies responsible.

### *Infection Control*

Because of the complexity of cancer care, nosocomial infection may occur in the process of treatment. The most susceptible are patients admitted for a long stay in the hospital due to treatment course and effective monitoring of clinical outcomes. Therefore, the services of infection control in cancer centers is very important. The function of infection control must focus on measures for the prevention and control of nosocomial infections and other infections that can be incurred in the process of treatment or diagnosis within the cancer center. Some of the main measures needed for infection control is hand hygiene, disinfecting and sterilizing surfaces and equipment, investigating and monitoring suspected infections, managing outbreaks, providing personal protective equipment, taking appropriate precautions, and vaccinating and educating health care providers. To achieve these measures, the infection control unit may use various means of communication to the patients, healthcare workers, and

other workers within the center on the implication of infections and personal prevention approaches. According to Raka (2010), infection control can introduce prevention bundles, improving compliance with hand hygiene, making prudent use of antimicrobials, translating research results into practice, and upgrading the capabilities of microbiology.

### *Quality Assurance*

Quality should be a theme associated to not only all aspects of cancer centers but the cancer care system as a whole due to the complexity of cancer care and the resulting risks and complication that may occur. No matter how small or big a workers' role is in the cancer system, quality as a theme should be associated to their duties. Therefore, the cancer system is required to have personalized as well as general indicators that is helpful in monitoring and assessing the quality and effectiveness of individual and collective duties. Similarly, there should be indicators for monitoring and assessing quality, safety and effective performance of structures, processes, and outcomes (Donabedian, 1966). The effective use of information technological systems will be helpful in measurement as well as assessment of baseline performance of each indicator and changes over time can be tracked. Therefore, it is the collective duty of leaders and stewards in the cancer care system to ensure regular quality check, monitoring, and assessment of performance in order to identify key areas that need improvement.

### *Finance*

Of course, the entire services and resources needed for cancer care system requires funding and financing to be realized. Without proper funding, then realization of an effective and efficient cancer care system is just a dream. Competent financial system should be established to not only monitor revenue and expenses, but to also attract investment and international financial support through practicing revenue generation. The sources of fund should mainly come from national level, however, financial sources can also come from subnational level (states, local government, communities), insurance companies, nongovernmental organizations, cross border contracts among countries, as well as international bodies etc. the availability of financial resources directed to the cancer care system determines the level of services to be rendered and



the overall performance of the system. The higher the financial support, the more the services and performance of the system and vice versa.

#### *Additional Key Supports*

The major requirements of a cancer care system has already been listed; however, the following additional support will be helpful in operation of cancer care system; equipment and technology support services, supplies and materials management, supply chain processes, patient transport, fire safety and radiation protection, occupational health and safety, and security. In some areas where there is high population, robbery or insecurities, additional support is also needed such as the employment of security personals to protect both patients and workers in the cancer care centers.

## CHAPTER 4

### METHODOLOGY

#### 4.1. Introduction

This chapter presents the overall research methodology used including details on research strategy and the approached utilized. The chapter also discusses comprehensively the fuzzy promethee method used for comparative analysis of Nigerian cancer care and other countries. Data collection and analysis methods are also vividly explained.

#### 4.2. Research Strategy

The study uses both primary and secondary data necessary for the accomplishment of the set-out goals and objectives of the study. However, due to the limitations of gathering data due to high cost involved, databases and other secondary data sources relevant to the thesis subject were utilized. Therefore, both quantitative and qualitative methodology is appropriate as the overall research strategy. According to Matthews and Ross (2010), both quantitative and qualitative methodology are capable of providing useful information in a research, however, the methods in their individual use have advantages and disadvantages. The combination of these methods (mixed methodology) can minimizes the disadvantages of one method and maximizes its strength by advantages of the other (Tashakkori and Teddlie, 2003). Mixed methodology allows for large information gathering.

Therefore, mixed methodology was used because it provides a greater breadth of perspective around the thesis subject for greater understanding. The quantitative methods were used to find statistical information about cancer care parameters for Nigeria and some selected countries so that it is possible to compare them using fuzzy promthee. On the other hand, the qualitative research method involves a comprehensive review of a large pool of secondary data regarding the state of cancer care in Nigeria and a review of the standard cancer care system. Both the qualitative and qualitative method used data from secondary sources (existing data bases such as consensus data, government reports, NGO's reports etc.), derived/compiled data (using data from different sources to create new data through some sort of transformation and simulated data).

### **4.3. Data Collection**

The research depended solely on secondary sources. As mentioned earlier, the thesis consists of both qualitative and quantitative methods of data collection. The qualitative method involves the comprehensive review of secondary data regarding the state of cancer care in Nigeria and a review of the standard cancer care system established by Gospodarowicz, et al., (2015). From these reviews, a new standard cancer system was customized for the case of Nigerian cancer taking in to consideration several local factors such as incidence, mortality and survival rate, risk factors, economic status of majority of Nigeria (if possible economic status of most cancer patients in the country), medical human resources, and the economic status and cancer budgeting in the country etc.

The quantitative research methods on the other hand involves the utilization of the excellent decision making and user friendliness of fuzzy promethee to comparatively analyze cancer care in Nigeria to top cancer treatment destinations in developing countries and around the world including India, United states, Turkey, Australia, and the United Kingdom. Vital parameters such as average cost of treatment, 5-year relative survival rate, doctors to patient ratio (DPR), security/safety/peace, clinical services & research, availability of clinical oncologists, ratio of new cancer incidence to an oncologist, number of cancer centers, quality of health systems, population, welcoming countries rank and tourism opportunities.

Afterwards, linguistic fuzzy scale of preference (triangular fuzzy linguistic scale) was analyzed to choose which criteria were more important than others and obtain the importance weight of each criterion value. The triangular fuzzy linguistic scale as shown in Table 4.1. The yager index was used to de-fuzzify each parameter values. Lastly, the de-fuzzified values was applied to PROMETHEE GAIA decision lab software with Gaussian preference function for analysis. In summary, the internet was used as a major source of secondary data including grey literature, Google books, Google Scholar, journals articles specialising in cancer issues as well as promethee applications, publications, report, standards, procedures, and policies of national and international organizations such as WHO and NCCP etc. all these sources were well referenced in the thesis.

**Table 4.1:** Linguistic scale of importance

<b>Linguistic Scale for Evaluation</b>	<b>Triangular Fuzzy Scale</b>	<b>Importance ratings of criteria</b>
<b>Very high (VH)</b>	(0.75, 1, 1)	Survival rate, Annual average cost,
<b>Important (H)</b>	(0.50, 0.75, 1)	DTP ration/100k patients, security,
<b>Medium (M)</b>	(0.25, 0.50, 0.75)	
<b>Low (L)</b>	(0, 0.25, 0.50)	
<b>Very low (VL)</b>	(0, 0, 0.25)	Tourism,

The basic steps of PROMETHEE method include six steps (Geldermann et al. 2000; Brans et al. 1986)

Step 1. For each criterion  $j$ , determine a specific preference function  $p_j(d)$ .

Step 2. Define the weights of each criterion

$$w_T = (w_1, w_2, \dots, w_k) . \quad (4.1)$$

The weights of each criteria is decided by the user (decision maker) which is observed according to the preference of the user. For example, if the criteria have equal importance, then the weights of each criterion will be equal and vice versa. And also normalization can be used for the weights;

$$\sum_{i=1}^k w_k = 1. \quad (4.2)$$

Step 3. For all the alternatives  $a_t, a_{t'} \in A$  define the outranking relation

$$\pi\pi(a_t, a_{t'}) = \sum_{k=1}^K w_k \cdot [p_k(f_k(a_t) - f_k(a_{t'}))], \text{ AXA} \rightarrow [0,1] \quad (4.3)$$

In this part, the preference index is indicated as  $\pi(a, b)$ . The preference index is a measure of magnitude of a user's preference in regards to an alternative  $a_t$  with respect to another alternative  $a_{t'}$  while considering all criterion simultaneously.

Step 4. The following formulas is used to obtain the leaving (positive) and entering (negative) outranking flows as follows:

- o Leaving (or positive) flow for the alternative  $a_t$ :

$$\Phi^+(a_t) = \frac{1}{n-1} \sum_{\substack{t'=1 \\ t' \neq t}}^n \pi(a_t, a_{t'}) \quad (4.4)$$

- o Entering (or negative) flow for the alternative  $a_t$ :

$$\Phi^-(a_t) = \frac{1}{n-1} \sum_{\substack{t'=1 \\ t' \neq t}}^n \pi(a_{t'}, a_t) \quad (4.5)$$

From the above formulas,  $n$  represent the number of alternatives. The comparative analysis for each alternative among the alternatives is  $n-1$ . Furthermore,  $\Phi^+(a_t)$  which is the positive outranking flow signify the strenght of alternative  $a_t \in A$ , while  $\Phi^-(a_t)$ , the negative outranking flow signify the weakness of alternative  $a_t \in A$ .

The PROMETHEE I has the ability to give partial preorder of the alternatives Via these outranking flows while the PROMETHEE II method has the ability to provide the complete preorder based on net flow, however it doesn't give much information about the preference relations.

Step 5. Determine the partial preorder on the alternatives of  $A$  according to following principle:

In PROMETHEE I alternative  $a_t$  is preferred to alternative  $a_{t'}$  ( $a_t Pa_{t'}$ ) if it satisfies one of the following conditions:

$a_t Pa_{t'}$ ) if;

$$\begin{cases} \Phi^+(a_t) > \Phi^+(a_{t'}) \text{ and } \Phi^-(a_t) < \Phi^-(a_{t'}) \\ \Phi^+(a_t) > \Phi^+(a_{t'}) \text{ and } \Phi^-(a_t) = \Phi^-(a_{t'}) \\ \Phi^+(a_t) = \Phi^+(a_{t'}) \text{ and } \Phi^-(a_t) < \Phi^-(a_{t'}) \end{cases} \quad (4.6)$$

When two alternatives  $a_t$  and  $a_{t'}$  have the same leaving and entering flows,  $a_t$  is in different to  $a_{t'}$  ( $a_t I a_{t'}$ ):

( $a_t I a_{t'}$ ) if:  $\Phi^+(a_t) = \Phi^+(a_{t'})$  and  $\Phi^-(a_t) = \Phi^-(a_{t'})$ .

$a_t$  is incomparable to  $a_{t'}$  ( $a_t R a_{t'}$ ) if;

$$\begin{cases} \Phi^+(a_t) > \Phi^+(a_{t'}) \text{ and } \Phi^-(a_t) > \Phi^-(a_{t'}) \\ \Phi^+(a_t) < \Phi^+(a_{t'}) \text{ and } \Phi^-(a_t) < \Phi^-(a_{t'}) \end{cases} \quad (4.6)$$

Step 6. Determine the net outranking flow for each alternative

$$\Phi^{\text{net}}(a_t) = \Phi^+(a_t) - \Phi^-(a_t) \quad (4.7)$$

Via PROMETHEE II, the complete preorder can be obtained by the net flow and defined by:

$$A_t \text{ is preferred to } a_{t'} \text{ (} a_t P a_{t'} \text{) if } \Phi^{\text{net}}(a_t) > \Phi^{\text{net}}(a_{t'}) \quad (4.8)$$

$$A \text{ is indifferent to } a_{t'} \text{ (} a_t I a_{t'} \text{) if } \Phi^{\text{net}}(a_t) = \Phi^{\text{net}}(a_{t'}). \quad (4.9)$$

Basically the better alternative is the one having the higher  $\Phi^{\text{net}}(a_t)$  value.

#### 4.4. Selected Cancer Care Parameters

The selected cancer treatment criteria include average cost of treatment, 5-year relative survival rate, doctors to patient ratio (DPR), security/safety/peace, clinical services & research, availability of clinical oncologists, ratio of new cancer incidence to an oncologist, number of cancer centers. Brief details of the above-mentioned criteria are discussed below briefly;

##### *Average cost*

Annual average cost for all the selected countries per patient are given as follows: USA \$150,000 (Moore, 2018), India \$18,182 (Nair, Raj, Tiwari & Piang, 2013), UK average of

£40,000 equivalent to \$51,240 (NHS, 2011), Australia \$33,400 (Paul, Fradgley, Roach & Baird, 2017)- similar price was reported in another journal \$33,944 (Goldsbury et al., 2018), and for Turkey, the estimated cost is greatly uncertain (Tatar, M. and I. Sahin, 2008)- however, the estimated Turkish government expenditure on cancer care is approximately \$2.5 billion (Nils W., Bengt J., and Daniel H., 2010). This means the annual average cost is \$16,666. Moreover, report in 2018 shows fall in cancer cases to 148,000 and an increase in government expenditure to \$3 billion. This means the estimated annual average cost is \$20270 (Sağlam, 2018). Annual average cost for all countries involved should be as low as possible. Lastly, the annual cost of cancer treatment in Nigeria is reported to range from N5 million to N20 million which is equivalent of 13886.4916 to 55545.9662 depending on the cancer (Muanya, 2019). Therefore the average cost is calculated to be \$6943.24578 for 10 cancer types. However, the estimate annual cost for diagnosis and treatment of cancer in Nigeria was \$15222.3720 (NCCP, 2018)

#### *Survival rate*

Relative 5-year survival rate is provided with the USA having 61.2% (American Cancer Society, 2018) and (Max R. and Hannah R., 2018). Australia 5-year survival rate from 2010 to 2014 was estimated at 69% (68% for males and 69% for females). That was an increase from 49% (1985–1989) to 69% (2010–2014) (Australia government, 2018). The UK has an estimated average 5-year survival rate of 50.1% for 18 of the most common cancers (Thaxter, 2018). India is reported to have a 5-year survival rate as only 30% (Varma, 2014 & Mudur, 2018). In Turkey, there is no specific data about 5-year survival rate from turkey. However, relative 5-year survival rate in the country calculated from World Health Organization (2014) shows that men have 41.6% while that for women is 67.5%. therefore, the average 5-year survival rate should be around 54.55%. for Nigeria, the 5-year relative survival rate was 24.4%.

#### *Doctors to patient ratio (DPR)*

This implies the number of medical physicians per 1000 or 100000 population. As was stated, the treatment of cancer is a collective team work of qualified and specialized medical staff (oncologists, radiographers, nurses etc.). According to a report, India 450,000 follow-up patients annually and newly registered 50,000 patients with a permanent staff (upper limit) of 150

doctors (Debarati, 2017). For Turkey, The Organization for Economic Co-operation and Development (OECD) in 2014, the average number of doctors per 100,000 population medical staff of 237 (Turkiye Odalar ve Borsalar Birligi, 2017). The USA from 2010 to 2016 saw an increase in ratio from 277 to 295 physicians per 100,000 population (Wikipedia, 2018). DPR in the UK 2.8 practicing doctors per 1,000 population, which is below the standard European average of 3.4 and below other major high GDP countries such as France, Germany, Spain and Italy (Donnelly, 2014). lastly, Australia have 392 medical practitioners per 100,000 population in 2015, which is an increase from 374 per 100,000 in 2012, 382 per 100,000 in 2013 and 388 per 100,000 in 2014. (AIHW, 2016). For Nigeria, there are 75 doctors to 100000 patients (Blog Editor, 2018; Adegoke, 2019)

#### *Security safety and peace*

No patient will like to visit a medical tourism destination when it is not safe. According to SafeAround, countries can be ranked from according to their safety in the following index from 100 meaning perfectly safe while 0 means extremely dangerous. The ranking takes in to consideration all kinds of threats to human including mugging, crime, road death toll, occurrence of terrorist attacks, wars etc. safety index for selected countries are; Australia 86.3, UK 76.5, USA 69.2, India 47.1, Turkey 44.8, and Nigeria 31.9.

#### *Clinical services and research*

Clinical services are the incorporation of general services from facilities, equipment, skilled personnel, and policies and procedures in order to deliver effective diagnosis therapy and supportive care. Cancer patient's access to a full range of clinical services encourages early and effective cancer diagnosis and treatment. A timely and accurate diagnosis is critical, because early detection makes the difference between a curable cancer and an untreatable one (Mary Gospodarowicz, et al., 2015). Moreover, cancer research is also important because it shows a country's commitment to fighting the cancer either by understanding how it works or finding new drugs and therapy (Docrates Cancer Center). For this parameter the ratio of citation per published clinical cancer research for the selected countries is given (Neumann, 2012) in the Table 4.2.



### *Availability of Clinical Oncologists*

As was stated earlier, the treatment of cancer is a collective team work of qualified and specialized medical staff (oncologists, radiographers, nurses etc.). A lack of well-trained clinical oncologists can result in significant cancer health disparities. Data on clinical oncologist workforce for the selected countries is presented in table 1 (Mathew, 2018).

### *Ratio of New Cancer Incidence to an Oncologist*

Data from the selected countries is provided in table 1 (Mathew, 2018).

### *Cancer Centers*

The number of cancer centers in the following countries is provided with USA, 49 Comprehensive Cancer Centers, 13 Cancer Centers, and 7 Basic Laboratory Cancer Centers. In total, the country has approximately 1,500 cancer centers (National Cancer Institute, 2018). Turkey is reported to have 198 cancer centers (Daily Sabah, 2018) and India 27 (India Against Cancer, 2018). The number of cancer centers in the UK is 13 (Bradbrook, 2017) and Australia has 1157 cancer centers (Lim, 2017).

### *Health systems*

All information about global ranking of health systems of the selected countries is provided in table 1 (Canadian Health Care Information, 2018).

### *Population*

All information about population for the selected countries is provided in table 1 (Worldometers, 2018)

### *Welcoming Countries Rank 2018*

Selected countries ranked by how many passports they accept visa-free, with visa on arrival or with Electronic Travel Authorization (eTA). Welcoming country score (WSC) (passportindex, 2018).

### *Tourism*

The parameters for medical tourism may further include condition of accommodation, country safety, shopping opportunities and general tourism/recreational activities. For this parameter, high number of visitors signify the popularity of tourism opportunities. The following tourism data in the selected countries is presented for 2017, the number of visitors to the respective countries.

UK recorded 35.8 million visitors. it was ranked the 6th most visited country in the world due to developed tourism infrastructure accompanied with an interesting history and culture. London receives most of the visitors while the Tower of London is the most visited attraction in the United Kingdom. Other popular places include Scottish Highlands, Stonehenge, Edinburgh, and York (Cripps, 2018).

USA recorded 75.6 Million visitors. The United States receives tourist throughout the year in such cities as New York, Los Angeles, Las Vegas. Most popular attractions include the Grand Canyon, Yellowstone National Park, the Alaskan subarctic wonders, Hawaiian beaches etc. other popular places include Grand Canyon, Manhattan in NYC, Yellowstone National Park with its geysers, Golden Gate Bridge in San Francisco, and Niagara Falls at the borders with Canada etc. (Cripps, 2018).

Turkey is always among the top tourist destinations with 37.6 million visitors. A very beautiful country with very rich historical and multi-cultural heritage. It also has unique breathtaking attractions and landscape. Istanbul is the most populous and popular city. Night life is epic in the city of Bodrum, Pamukkale's offers visitors perfect relaxation with its thermal spa terraces, Kahramanmaraş for amazing ice creams and Antalya for beautiful sand beaches etc. other popular places include Cappadocia, Ephesus, Bodrum, and Side (Cripps, 2018).

India recorded 14.6 million visitors. It has a rich cultural and historical heritage. It has the famous Taj Mahal which is one of the world's seven wonders. Popular visited places in India include Meherangarh Fort, Khajuraho Temples, Agra Fort, Amber (Amer) Fort and Palace in Jaipur. (Szabo, 2018).

Australia recorded 8.12 million visitors. With coastal cities in Sydney such as Brisbane and Melbourne, Australia is a good place to have a stop. Other popular places include regional Queensland, the Gold Coast and the Great Barrier Reef (world's largest reef), Uluru, the Australian outback, the Tasmanian wilderness. The unique Australian wildlife is also another significant point of interest in the country's tourism. (Statista, 2018).

**Table 4.2:** Selected cancer parameters for Nigeria, USA, UK, India, Turkey, and Australia

Parameters	Nigeria	USA	India	UK	Australia	Turkey
Annual average cost \$	15222	150,000	18,182	51,240	33,400	20,270
Relative 5-year survival rate	24.4%	61.2 %	30 %	50.1 %	69 %	54.55%
DTP ration/100k patients	75	295	150	280	392	237
Tourism (millions)	1.889	75.6	14.6	35.8	8.12	37.6
Security, safety & peace %	31.9	69.2	47.1	76.5	86.3	44.8
Clinical services & research citation/articles		22.4		17.5	21.5	5.5
Number of Oncologists	26	11,700	1,500	476	448	400
New cancer case/oncologist	3,923	137	677	689	272	370
Approved cancer centres	9	1,500	27	13	1157	198
Health system	187	37	112	18	32	70

WSC	198	79	20	53	78	25
Rounded Population (Billion)	0.200	0.327	1.354	0.067	0.025	0.082

#### 4.5. Promethee Application for Comparing Cancer in Selected Countries

Nigeria, India, Australia, Turkey, USA, and the UK were considered as alternative cancer treatment destinations. The criteria (parameters) equally applied to these treatment destinations include average cost of treatment, 5-year relative survival rate, doctors to patient ratio (DPR) per 100k, security/safety/peace, clinical services & research, availability of clinical oncologists, ratio of new cancer incidence to an oncologist, number of cancer centers, quality of health systems, population, welcoming countries rank and tourism opportunities.

Afterwards, linguistic fuzzy scale of preference (triangular fuzzy linguistic scale) was analyzed to choose which criteria were more important than others and to obtain the importance weight of each criterion value. The triangular fuzzy linguistic scale as shown in Table 4.1. it is important to note that the weights each parameter used in this analysis is based on an expert opinion, arrived upon from experience with cancer treatment quality. These weights can also be altered depending on the decision maker. The yager index was used to de-fuzzify each parameter values because yager index considers all the points and is not hugely affected by extreme values or weights. Lastly, the de-fuzzified values were imputed in to PROMETHEE GAIA decision lab software with Gaussian preference function for the comparative analysis of 5 alternative cancer destinations.

The Gaussian preference function was applied to each criterion using visual PROMETHEE decision lab program. Table 4.3 shows the parameters and weights of the criteria including the values of the parameters used for the analysis. Gaussian preference function has been preferred over the other preference functions due to the fact that it does not take into account and is not affected by minute and inconsequential deviations in the input values of the parameters (Parreiras & Vasconcelos, 2007).

Due to lack of space in the Table 4.3, parameters are represented as annual average cost (AAC), relative 5-year survival (RYS), doctors to patient ratio (DPR/P) per 100k (DPR), SSP, research (R), number of oncologists (NOF), ratio of new cancer/oncologist (RON/O), approved cancer center (ACC), health system (HS), rounded population billion (RPB), WSC, and tourism (T), Gaussian (Gauss) in Table 4.3.

**Table 4.3:** Visual PROMETHEE Application for Retinoblastoma Treatment Alternatives

<b>Criteria</b>	<b>AAC</b>	<b>RYS</b>	<b>DPR/ P</b>	<b>T</b>	<b>SSP</b>	<b>R</b>	<b>NOF</b>	<b>RON/ O</b>	<b>AC C</b>	<b>HS</b>	<b>WS C</b>	<b>RPB</b>
<b>Unit</b>	\$	%		million	%							Billion
<b>Preferences</b>												
<b>(min/max)</b>	<i>min</i>	<i>Max</i>	<i>max</i>	<i>max</i>	<i>max</i>	<i>max</i>	<i>max</i>	<i>min</i>	<i>max</i>	<i>min</i>	<i>max</i>	<i>min</i>
<b>Weight</b>	0.5	1.0	0.75	0.25	0.75	0.75	1	0.75	1	1	0.25	0.25
<b>Preference Function</b>	<i>Gauss</i>	<i>Gauss</i>	<i>Gauss</i>	<i>Gauss</i>	<i>Gaus s</i>	<i>Gaus s</i>	<i>Gaus s</i>	<i>Gauss</i>	<i>Gaus s</i>	<i>Gaus s</i>	<i>Gaus s</i>	<i>Gauss</i>
<b>Evaluations</b>												
<b>Nigeria</b>	15222	24.4	75	1.889	31.9	N/A	26	3923	9	187	198	0.200
<b>USA</b>	15000 0	61.0	295	75.600	69.2	22.4	1170 0	137	1500	37	79	0.327
<b>India</b>	18182	30.0	150	14.600	47.1	N/A	1500	677	27	112	20	1.354
<b>UK</b>	51240	50.1	280	35.800	76.5	17.5	476	689	13	18	53	0.067
<b>Australia</b>	33400	69.0	392	8.120	86.3	21.5	448	272	1157	32	78	0.025
<b>Turkey</b>	20270	54.6	237	37.600	44.8	5.50	400	370	198	70	25	0.082

## CHAPTER 5

### FINDINGS AND DISCUSSION

#### 5.1. Promethee Result

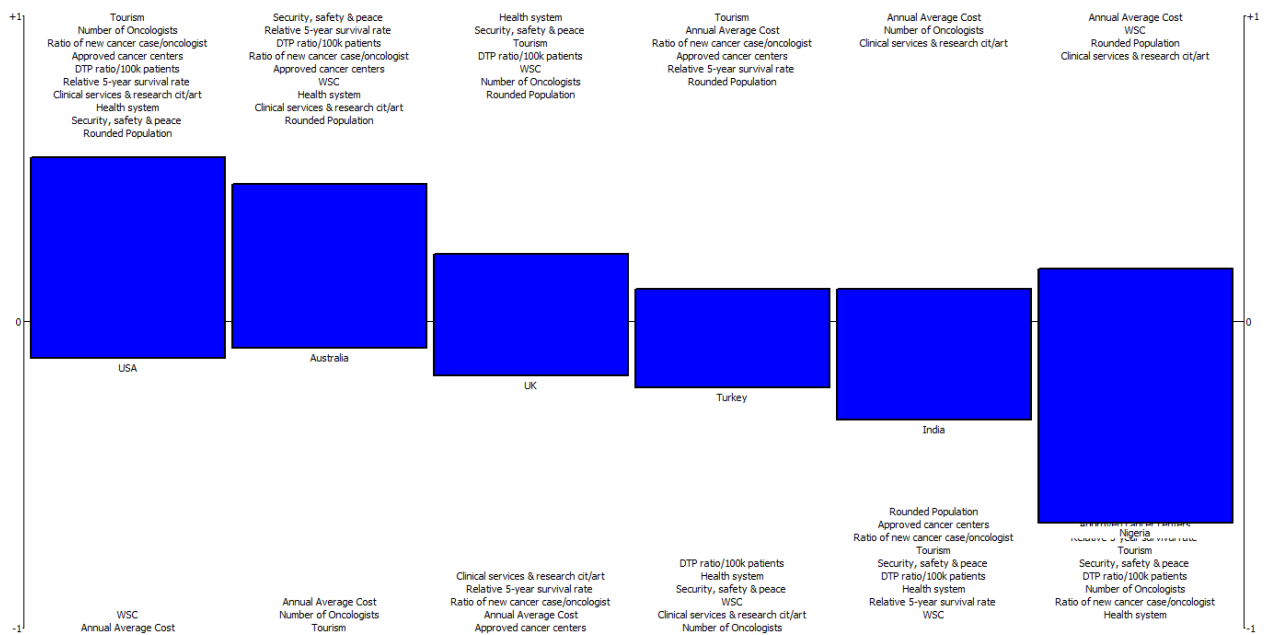
In regards to the parameters being considered for the selected countries as well as the importance scale of importance applied to the parameters, the PROMETHEE GAIA decision lab software provided the positive, net and negative outranking flow for each of the selected alternative cancer destination as shown in Table 5.1. The positive outranking flow signify the cumulative performance of a given cancer destination in terms of the conditions provided. While the and negative outranking flow signify low performance. The net flow is the distance between positive flow and negative flow which provides the full ranking.

**Table 5.1:** PROMETHEE GAIA decision lab software results showing the completing ranking of the alternative cancer treatment destinations with their positive, net and negative outranking flows

<b>Complete Ranking</b>	<b>Treatment Destinations</b>	<b>Positive outranking flow</b>	<b>Net flow</b>	<b>Negative outranking flow</b>
1	USA	0.6272	0.4160	0.2113
2	Australia	0.6047	0.3592	0.2450
3	Turkey	0.4438	0.0414	0.4025
4	UK	0.3612	-0.1116	0.4748
5	India	0.2997	-0.2183	0.5180
6	Nigeria	0.1679	-0.4872	0.6550

From Table 5.1 above, USA has the highest positive outranking flow as well as the lowest negative outranking flow with 0.6272 and 0.2113 respectively. Australia is second with a positive and negative outranking flow of 0.6047 and 0.2450 respectively. On the other hand,

Turkey comes third with positive and negative outranking flow values of 0.4438 and 0.4025 respectively. The UK is ranked fourth with positive and negative outranking flow values of 0.3612 and 0.4748 respectively. India is fifth with positive and negative outranking flow values of 0.2997 and 0.5180 respectively. Nigeria comes last with lowest positive outranking flow value of 0.1679 and highest negative outranking flow of 0.6550. Furthermore, Figure 5.1 shows us more details of the ranking.



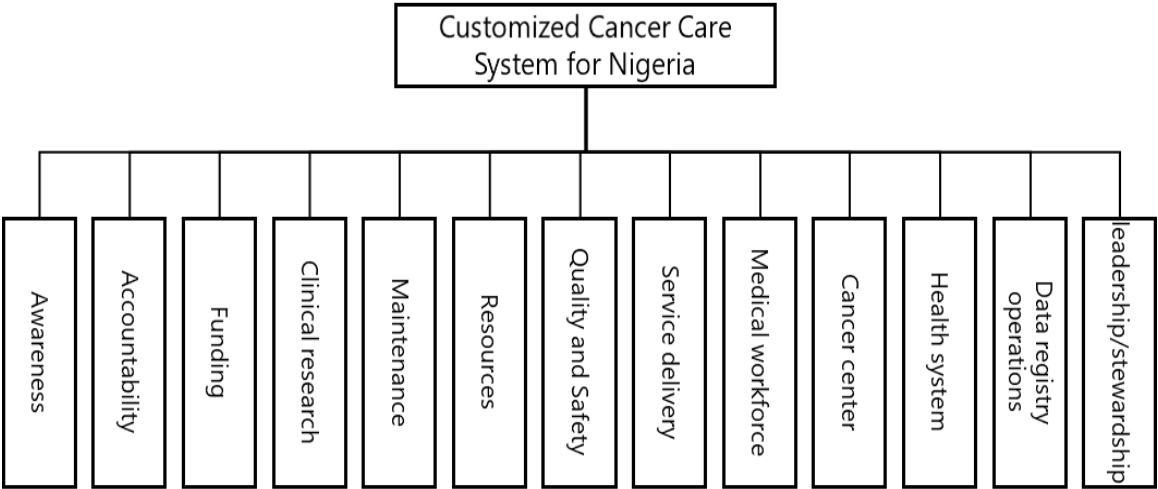
**Figure 5.1:** Ranking showing the parameters for each alternative treatment destination in their positive and negative outranking flow

USA was ranked the highest because she has several parameters (weighted as very important in the ranking scale) in its positive ranking flow. USA is only weak in terms of her health system, tourism (annual number of visitors) and ease of obtaining visa (WSC). Moreover, Nigeria was ranked the lowest because only few parameters such as ease of obtaining visa (WSC), average annual cost, health systems and in number of approved cancer centers. In general, the parameters for USA, Australia, the UK and Turkey are on the positive outranking flow compared to the

India and Nigeria. The United Kingdom has her parameters roughly shared between the negative and positive outranking flow. Decision Lab visual PROMETHEE program was used to have the result. This program is user friendly and the decision maker can change the criterion easily and can compare the therapy techniques according to parameters they wish.

**5.2. Customized Cancer Care System for Nigeria**

The Comprehensive and Standard Cancer Care System framework customized for Nigeria, classifies the main parameters of cancer care system in to leadership/stewardship, data management and registry operations, health system, cancer center, clinical research, medical workforce, service delivery, quality and safety, resources generation, funding and financing, maintenance, accountability, and awareness/community outreach. The customized models follow the framework used by Gospodarowicz et al. (2015), Association of Community Cancer Center (2012), and Prager (2018).



**Figure 5.2:** Parameters for customized cancer care in Nigeria

*Leadership/stewardship*

For any system to be actualized, leadership and stewardship must be effectively implemented. In Nigeria, the administrative structure for cancer care is the federal ministry of health lead by Prof. Isaac Folorunso Adewole. The administrative leadership of the federal ministry of health should be responsible for establishment of cancer control plan which can be evidence or



population based with the sole aim of preventing cancer occurrence and improving survivorship across all parts of the country. The federal ministry must also be responsible for establishing and maintaining/evaluating high standards, guidelines, and procedures of clinical services to cancer patients by effective utilization of human, fiscal, and material resources. This means they must establish stewardship teams that will see to the effective and efficient implementation and maintenance of these processes across all health care facilities in the country. Accreditation of cancer care facilities and medical personal can be a responsibility. In general, the federal government must be held accountable for the development as well as maintenance of limited resources to both sustain and increase the cancer care programs and its efficiency to meet the growing pandemic cancer cases and the needs of the Nigerian population.

Under the federal government, there should be several other departments and sub departments such as cancer program committee, medical committee, and biomedical/clinical engineers committee etc. Contrary to popular practice where the minister of health has to be a medical doctor and, in some cases, from a totally different field, the administrative leadership for cancer care system can be handled by health care managers as well as biomedical/clinical engineers. Biomedical/clinical engineers are trained to provide the most effective and efficient medical technologies that are at the same time cost effective (under budget). Also because of their medical, engineering, and health management background, they can fit in the management of all cancer center facilities. In general, the administrative leaders must be qualified by education (4 years degree, masters and PhD will be of great advantage) and long-term experience (usually 4 to 6 years) that appropriately match the responsibilities required for this position.

#### *Data Registry Operations*

As presented in the literature review, data regarding cancer cases and most of the data presented by international organizations were based on estimations. Even the data used for the 2018 national cancer control plan in Nigeria were based on 2012 estimated data by WHO. The significance of cancer registry cannot be over emphasized, it contributes to administrative and programmatic planning, patient treatment planning, research, staging, and continuity of care through data retrieval and monitoring of outcomes through annual analysis, and long-term

follow-up. Cancer patient data must be accurate and collected on a timely manner and an appropriate follow up should be associated.

In order to move forward in the fight against cancer in Nigeria, data registry and management have to become an integral part of the cancer care system. By this way, we can be able to know the annual incidence, prevalence, and mortality rates of cancer in the country. Therefore, an effective and efficient data registry and management system must be established and implemented. It should include data on vital cancer parameters such as incidence, prevalence, mortality rate, stage of cancers types of cancer, demographic information and so on. The cancer registry system should be updated, improved with quality, it should also be control by a cancer committee.

#### *Health System*

Cancer care system is a system within a health system. According to WHO, it is the principal function of the health system of a country to provide stewardship, financing (including budgeting), generation and allocation of resources, as well as service delivery. Unfortunately, Nigeria ranks 187 out of 190 countries of global health system. As discussed earlier, cancer care involves care of patients from prevention, screening, diagnosis, treatment, survivorship, palliative, and integrated care which involves the services of medical professionals at all segments of the healthcare system. For example. Nurses and physiotherapists are required for the palliative care. Also, the intensive unit is needed in case of a serious cancer complication. Therefore, an effective and efficient health system is useful for the success of a cancer system.

#### *Cancer Center*

The cancer center in Nigeria should be similar to the framework provided in chapter three. The function of the cancer center should be broadly divided in to three sections; clinical management, clinical services, and core services. There should be a multispecialty team of professionals who will be responsible for the planning, implementation, as well as evaluation of care for cancer patients and their family members and friends. The multispecialty team should include the services of medical oncologists, nurses, pharmacy, psychosocial oncology, pain

management, nutritional support, rehabilitation, case management, discharge planning, data management/registry, children services, cancer education, control and detection program, general risk assessment, counselling and testing, clinical research, palliative, supportive and integrated care, hospice, and pastoral care etc.

### *Medical Workforce*

Since a comprehensive cancer care system requires the collective effort of multispecialty team of medical workforce, the federal government of Nigeria should make it a priority to recruit medical workers especially those needed for entire care of cancer. As data shows, Nigeria has 75 number of doctors to patient per one hundred thousand people for a population of more than two hundred million people. Also, Nigeria only has 26 number of registered oncologists in the country which makes the ratio of new cancer cases to an oncologist very high (3,923). The government can achieve increase in the number of medical workforces by analyzing the current and projected incidence of cancer cases. By this way, the number and type of needed medical workers may be determined (and the number of specialized medical personals for each case such as oncologists, radiologists, chemotherapists and so on) in order to achieve the ultimate goal of cancer care system.

Some of the possible ways the government can increase the medical workforce in the long run include, admission of interested candidate students in to universities and other healthcare education institution, reduction in educational fees as well as providing grants to interested students, revitalizing and improving the educational system for better training, increase in salary and other benefits for medical workers not only attract potential candidates within Nigeria and neighboring countries, but it also motivate other workers towards achieving the goals and objective of the cancer care system. The condition of cancer changes rapidly with new cancer risks and the morphology of the body, therefore continuous research and cancer education is required for the medical workforce, the patients as well as the general population. there should be periodic seminars, workshops and other educational events and activities for medical personals at the local level, national level, and if possible, the international level.

### *Service Quality and Delivery*

As discussed in the literature review, the administration of cancer care services should be observed by a set of guidelines, standards and procedures for the purpose of quality. It is the responsibility of the stewardship team (which should be provided across all regions of Nigeria) to make sure all cancer centers and the medical workers adhere to the standards accredited by the federal ministry of health as well as international bodies. Furthermore, there should be a multispecialty team that will establish quality improvement plan that should be developed to address the areas that are failing to meet the goals of the cancer care system. This quality improvement plan can be achieved through quality review data, including attributes of timeliness, appropriateness of care, clinical outcomes, and effective management of disease sequelae and treatment toxicities.

In general, cancer quality and service delivery are achieved through effective implementation of the guidelines, standards and procedures and the collective duty of all medical workers and other support workers at all levels in their individual and collective duties. Some examples were improvement may include improvement in is accuracy and efficiency in outlined process for delivering patient care, improvement in community-based programs, improvement in access to cancer care services, reducing cost, risks and complication as well as improving cancer patient satisfaction etc.

### *Resources*

This includes all the direct and indirect resources needed for successful implementation of the cancer care system. In other words, direct resources refer to medical resources needed for diagnostic, therapy and other medical related services such as screening/diagnostic machines, therapy machines, sterilization machines, and other medical infrastructure while indirect resources refer to amenities needed for successful run in cancer care centers including electricity, clean water, accessible road, computer/ICT machines, telephone and internet services for cancer helpline, waste management, and petroleum needed for medical supplies, transportation of goods, personnel, and patient, and fuel for lighting, heating, cooling, and

medical equipment. Nigeria can afford all the necessary resources required for a successful cancer system.

For example, the federal government can heavily subsidize the importation of medical supplies for both government and private cancer centers and encourage local production of these supplies. The government can also subsidize the price of petroleum, electricity, and water as support to both public and private health institution with the sole aim of improving cancer care services in the country. For direct resources, the federal government should reconsider the role of medical suppliers in the country and employ the services of qualified biomedical and clinical engineers who are trained to survey the medical technological needs of healthcare institutions in communities, states or the entire country at large. Biomedical engineers can also be supported by the federal government to manufacture customized medical devices for the country.

#### *Maintenance*

Nigeria as a whole has poor maintenance habit. The first internationally accredited cancer center in west Africa was built in Abuja, Nigeria and it was well equipped at the beginning, however, due to the poor maintenance attitudes in Nigeria, the cancer center is not function to its full capacity. By maintenance, it means the entire cancer care system and its activities must be maintained at all levels and all workers at all levels must be held accountable. The medical devices and machines must undergo monthly and annual services to prevent any chances of wrong medical services and any major failure. If there is no maintenance, then successful implementation cannot be achieved even the best cancer care system will not be able to achieve success without maintenance. Therefore, maintenance of the entire cancer care system is a principal part of the system that needs ultimate attention.

#### *Clinical Research*

Clinical research is very important to combat diseases especially very invasive diseases that may probably be challenging by providing breakthrough treatment, prevention, diagnostic, screening, and quality of life (supportive care) trials. Leading countries in the aspect of cancer care are at the forefront of clinical cancer research on different approaches to tackle cancer. In

America, due to the support on clinical cancer research and other aspect of cancer care system, the survivorship for cancer increased significantly. Therefore, there should be provision for clinical research in Nigeria and cancer patients should be provided access to clinical research program.

By observing and encouraging clinical cancer (trials) research, there could be breakthrough in new advanced and promising approaches of therapy as well as diagnosis. A well-designed treatment plan for a patient is achieved through conducting clinical research by addressing important factors and questions associated to individual patients. Most importantly, clinical research may use the available resources in Nigeria to provide solution for cancer treatment and general care in Nigeria. The federal government, and non-governmental organizations should support clinical research done by community oncologists and centers since the outcomes of these trails usually provide improved or advanced pathways for advancement of knowledge while protecting the safety, prerogatives, and confidentiality of the patient.

### *Funding*

Without funding, no part of the cancer care system can come to realization. The estimated cost needed for 5-year implementation of the 2018 national cancer control plan (NCCP) in Nigeria is estimated at ₦97,321,725,422.53 which is equivalent to \$308,957,858.48. considering the wealth of Nigeria, this amount can be easily generated to tackle the pandemic level of cancer. However, this figure cannot be entirely trusted due to the state of corruption in Nigeria. The estimated budget is ridiculously high in the sense that unnecessary padding of any budget in Nigeria is not a new case and it a huge shame that the responsible authorities may unnecessarily pad the estimated budget for their personal gain at the end of the day and the NCCP will not be realized, hence everything will be at the expense of the poor cancer patients. This is why the leadership system proposed for cancer care in the country is important where accountability at all levels can be achieved. Furthermore, Nigeria needs to employ the services of qualified biomedical/clinical engineers and healthcare managers who are trained to explore affordable medical devices that are still effective.

Funding for the cancer care system is huge topic of discussion, however the federal government can fund comprehensive cancer care system across the country. For instance, if the federal government commit 5 % from each of her of monthly or annual revenue sources to cancer care, a huge step towards funding challenges can be tackled. This 5 % should be considered separate from the annual healthcare budget and the annual allocation for cancer care.

### *Accountability*

Accountability should be enforced on all workers within the cancer care system at all levels. Corruption is a major issue in Nigeria; therefore, the ministry must be health accountable at all levels. In order to prevent corruption, this system is divided in to the leadership, funding and accountability authorities with each of them having special authority on the other. the leadership must develop, implement standards for the overall system which will require funding, however, the duty of the funding or financing team is to evaluate the proposed budget by the leadership team in order to avoid traces of corruption. The accountability team on the other hand should have the authority to hold both the leadership, the funding team and all segments of the cancer care system on accountable in regards to financed projects and programs, procedures and standards implementation and the overall performance of the system. I believe this will reduce corruption and catalyze the progress in reducing cancer incidence and increasing survivorship in the country. Therefore, it is the administrative duty of the federal ministry of health to exhibit commitment in providing excellent cancer care, developing a team of multidisciplinary staff, as well as the provision of comprehensive cancer programs and services to the poor and moderate cancer patients in Nigeria.

### *Awareness*

Creation and spreading of awareness are very vital for reducing the incidence of cancer. When people are informed of the various risks and factors of cancer, they will prevent several situations that could potentially make them susceptible to cancer. Moreover, educating the general population on a regular basis to stop the stigmatization of cancer patients and encourage others to come forward for early screening before cancer reaches advance stage. This will help curb negative perception of cancer in Nigeria. The government (both locally and nationally)

should organize community outreach programs to educate the general public about the pandemic level of cancer cases in Nigeria and how it kills people if diagnosis and treatment is not started early. The educational programs and materials should contain information about cancer control, early identification and detection of cancer through self-examination, susceptibility to cancer by risk factors (such as age, gender, family history, environment occupation, and lifestyle modification etc.), how to reduce these factors, screening guidelines, guide to nearest cancer care centers and cancer hotline.

Hospitals and other cancer care facilities should provide education and educational materials to cancer patients and their families, friends, caregivers so that they can be informed about treatment plans, prognosis, risk, and bring hope to them. This will also encourage them to make informed decisions of alternative therapy techniques and symptom management, thereby improving the general quality of life. All cancer educational plan should be established carefully and must be sensitive to cultural, religious, and ethnic beliefs of high-risk groups that may be offended if approached about cancer, therefore knowledge and wisdom should be incorporated by cancer educators, the news agencies, media outlets and other means of spreading awareness.



## CHAPTER 6

### CONCLUSION AND RECOMMENDATION

This thesis was able to provide a comprehensive review on the current state of cancer care in Nigeria and the challenges the country is facing in order to tackle them. The study also reviewed the standard cancer care system that was established by previous researchers from which a customized standard care system for Nigeria was established. The customized model took in to consideration vital parameters needed for successful implementation of the system in Nigeria. These cancer care system parameters include leadership/stewardship, data management and registry operations, health system, cancer center, clinical research, medical workforce, service delivery, quality and safety, resources generation, funding and financing, maintenance, accountability, and awareness/community outreach. The need for uniform cancer care protocol, guideline, procedures and standards across all health care centers in the country was emphasized.

Fuzzy PROMETHEE, a promising a multi-criteria decision-making model which effectively compare alternative criteria was used to compare Nigeria as a cancer treatment destination with other countries including the UK, US, Australia, India, and Turkey. The study shows that the proposed PROMETHEE method is very effective at giving solutions to decision-making problems in closely related criteria. Our study is in agreement with previous studies of other researchers. It simply and clearly showed that fuzzy PROMETHEE provides a ranking of alternative cancer treatment destinations. The result of our comparative analysis is solely dependent on the selected parameters and our weighing of the parameters. This study can be improved with more parameters, and improved weighing.

Although the study gave an overview of perception and awareness of Nigerians towards cancer, futures studies should focus on other crucial factors that may affect the success of a comprehensive cancer care in Nigeria. Since Nigeria is a multi-cultural, regional and religious country, culture as a parameter should be taken in to consideration. Future studies may

concentrate on the impact of cultural and religious believes. The federal government of Nigeria should incorporate the financial burden of cancer screening, diagnosis, and treatment in to the National Health Insurance Scheme (NHIS) so that cancer patients do not have to pay out of pocket. The federal government should also take in to consideration the large population of poor cancer patients who are not able to afford or are struggling financially with cancer care services. Therefore, appropriate actions on affordability of cancer should be implemented. How Nigeria can make cancer care affordable or free for the moderate and poor Nigerians can be a focal point of future research. The role of indigenous biomedical/clinical engineers should be reconsidered in moving forward with not only technologizing cancer care in Nigeria, but the entire healthcare system in the country.

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